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EYQ

# What's after what's next?

**The upside of disruption**

Megatrends shaping 2018 and beyond



The better the question. The better the answer.  
The better the world works.

The EY logo, consisting of the letters 'EY' in a bold, white, sans-serif font. A yellow triangle is positioned above the 'Y', pointing to the right.

Building a better  
working world

# Foreword

Welcome to EY's new *The upside of disruption* report. When we launched the previous report in 2016, those considering disruption as a top business challenge were in the minority. Today, corporate leaders almost universally see disruption as both an opportunity and an existential threat. Responding necessitates a view that is both wider and more narrowly focused.

Generated by the EY global think tank, EYQ, the latest issue of EY's Megatrends report helps to resolve this apparent duality by exploring the key disruptive trends of the future while explaining where disruption comes from and where it's headed.

We take a look at how human augmentation technologies (artificial intelligence, robotics, AR/VR, blockchain, autonomous vehicles) will reinvent the future of work, consumer engagement, behavioral design and regulation. We explore how technology will reinvent the production of food and enable manufacturing at the molecular scale. And we delve into the changing future of urbanization, health and sector convergence.

The report also looks at disruption through a framework that highlights four distinct kinds of change: primary forces, megatrends, future working worlds and weak signals. These elements occur at different times, and with different levels of uncertainty and scales of impact. Most meaningfully for corporate decision-makers, they demand different kinds of responses.

In distinguishing between causes and effects, our framework can help organizations prioritize among a seemingly endless set of disruptive forces.

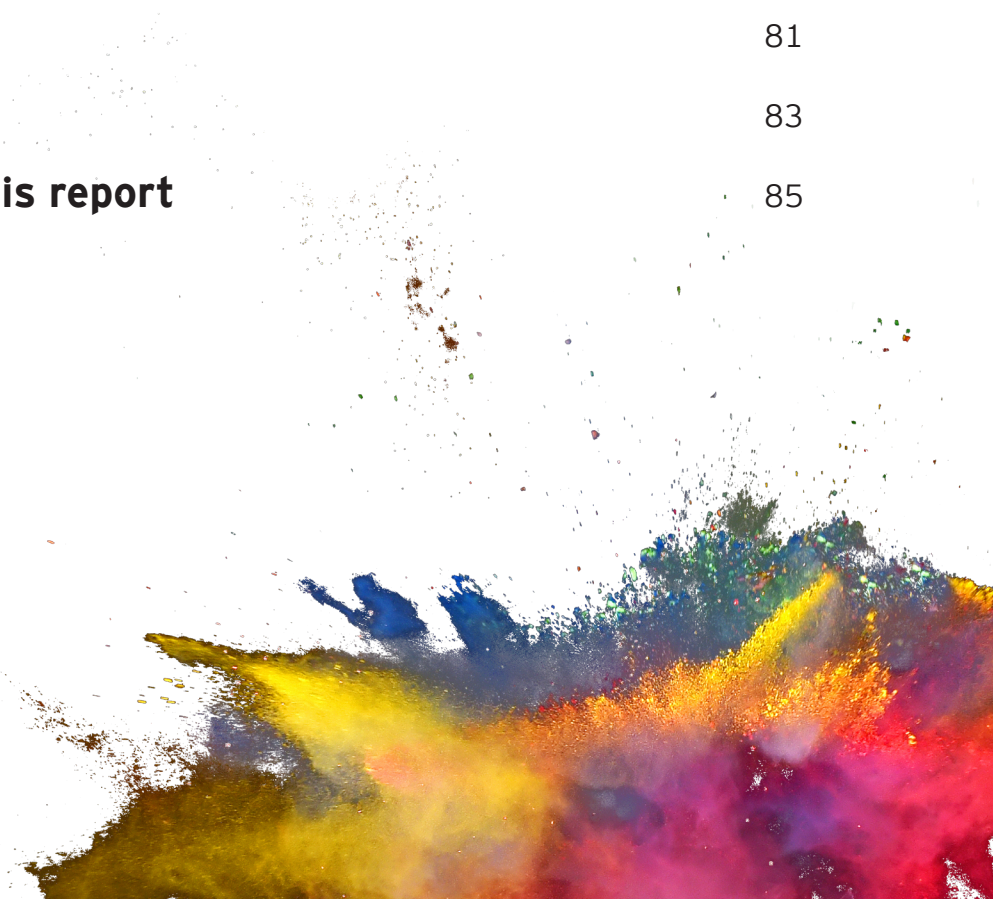
Organizations need to be ready to seize the upside of disruption. They need to know where disruption is coming from, where it's headed and what it means. EY's 2018 *Megatrends* report, and our framework for change, can help organizations establish the right baseline for a strategy that can turn downsides into upsides, and threats into opportunities.



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# Introduction

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The intersections between new waves of primary forces – and between megatrends themselves – creates new megatrends and future working worlds. Understanding this connectivity is key to responding to disruption. For this reason, we have highlighted these interconnections using yellow text. Follow these yellow hyperlinks to see how different elements connect with each other.

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We live in interesting times.

We are surrounded by the everyday miracles of smartphones and sensors. We see retailers swept away by the relentless tide of e-commerce. We are so inundated by stories about driverless cars that they seem like old news – years before anybody in the world has even owned one. Change is constant, and we are inured to it.

So, it should not be surprising that much has changed since we launched our last **Megatrends** report in April 2016. Yet, even against the backdrop of constant change, much of what is unfolding before our eyes is truly astonishing – even unprecedented.

Consider the political earthquakes of 2016 and the aftershocks that followed. In rapid succession, voters in the UK voted to leave the European Union, while citizens of the US elected to the most powerful office in the world a political neophyte whose electoral prospects had been roundly dismissed by pundits and pollsters alike. In the months that followed, **populists and nationalists** were newly energized, giving mainstream parties a run for their money.

Or, consider the extreme climate events that have struck so much of the world. In 2017, Hurricane Harvey hit Houston with more than 60 inches of rain in just five days – the most extreme rainfall event in US history. Meanwhile, Mumbai and other cities across south Asia were paralyzed by floods caused by one of the heaviest monsoons on record. As this report is being released, Cape Town may soon become the world's first major city to run out of water.

Now, consider something that is further in the future but truly unprecedented and revolutionary. We are entering the **era of human augmentation**. While technology has always augmented human capabilities, the technologies that are now coming into their own, including artificial intelligence (AI), robotics, autonomous vehicles (AVs) and blockchain, promise to go further. For the first time in human history, technologies will be able to act **autonomously** on our behalf with far-reaching consequences for everything, from **work** to **marketing** to **regulation**.

## Disruption requires a wider – but more focused – point of view

Corporate leaders have not always viewed disruption as a top business challenge. That has now clearly changed. Executives and board members are focused on disruptive innovation as never before, recognizing it as both an opportunity for differentiation and an existential threat. Companies have stopped wondering whether it merits serious attention and are focusing instead on how to best respond. Business transformation has become the new mantra as companies adapt to the era of disruption with digital strategies, new business models and more.

Responding requires a view that is simultaneously wider **and** more narrowly focused.

Consider how disruption is already widening the playing field. A decade ago, financial services companies looked primarily within their peer group for competitive threats. Today, they are focused more broadly, including on disruptive financial and regulatory technology entrants and cryptocurrencies. Similar shifts have occurred across practically every sector, from automotive to telecommunications.

But, the events we've described here suggest the need for an even wider view. Disruption does not stem solely from innovative startups and technologies. Political events and climate change can create disruption as well. Regardless of the source, these trends are disruptive for businesses and governments. They shift market power among competitors, challenge existing business models and approaches, realign trade patterns, reorient supply chains, drive business relocations, and more.

Even as disruption demands a broader perspective, it calls for a narrower focus. It necessitates prioritizing and emphasizing the most important challenges in an ever-expanding universe of potentially disruptive trends.

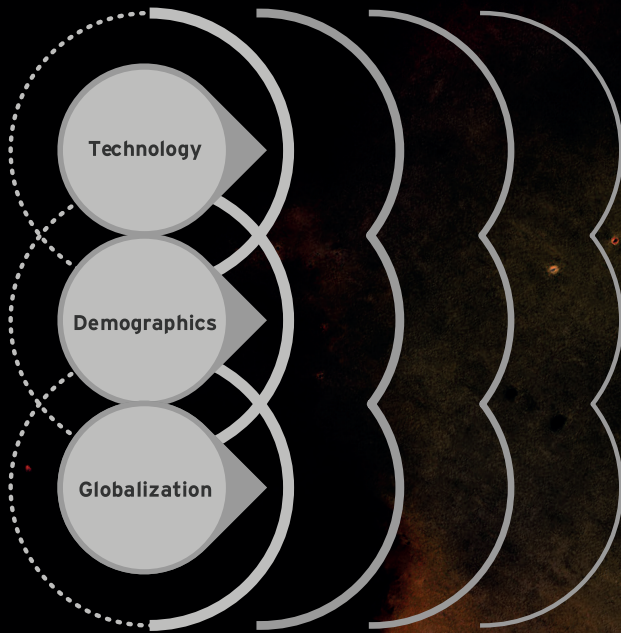
How do you resolve this apparent duality – and where do you start?

# The upside of disruption

A framework for understanding where disruption comes from, where it's headed - and what it means for you

## Primary forces

- > Evergreen, evolve in waves
- > Root causes



## Megatrends

- > Medium term (3-10 years)
- > Cross-sector disruptions



## Future working worlds

- > Long term (more than 10 years)
- > New rules of the game



**Convergence themes**  
(Value creation at the intersection of industries)

- 1 Shopping-buying divergence
- 2 Lifestyle as a service
- 3 Precision health 4.0
- 4 Urban mobility ecosystems
- 5 Smart neighborhoods
- 6 Food facts, not fiction

## The answer is a framework for disruption

We propose that harnessing disruption requires a framework for bringing order to the chaos – distinguishing between causes and effects, and prioritizing among a seemingly endless set of disruptive forces.

EY's framework accomplishes this by highlighting how the shifts often loosely called "megatrends" are, in fact, four distinct kinds of change. In addition to megatrends,

these include primary forces, future working worlds and weak signals. We explain these four forces in detail here and explore them in the rest of this report.

The four elements of our framework occur in different time frames with different levels of uncertainty and different scales of impact. Most significantly for decision makers, they call for different kinds of responses.

### Primary forces

**Primary forces** are the root causes of disruption.

We identified these through a root-cause analysis, similar to Toyota's legendary "5 whys\*" process. We listed every disruptive trend we could identify and asked ourselves what was causing it. We then identified the causes behind those causative factors, and so on, until we could go no further.

At the end of this process, we found that the vast majority of disruption originates in some combination of three primary forces: technology, globalization and demographics. These forces aren't themselves new;

they have been around for centuries or millennia. But, they evolve in waves and each new wave is disruptive in different ways. For instance, while technological disruption goes back to at least the first Industrial Revolution, it has disrupted business in distinct waves; recent waves include mobile, social and sensors.

In this year's *Megatrends* report, we highlight three examples of the latest waves occurring in each of the primary forces: **human augmentation** (technology), **populism** (globalization) and **aging** (demographics). These topics form core themes for this report, which we explore through several megatrends.

\* <https://hbr.org/2012/02/the-5-whys.html>



## Megatrends

The interaction among the new waves of primary forces engenders new **megatrends**. For instance, the **Health reimagined** megatrend is driven by digital health (technology), aging populations (demographics) and the sedentary lifestyles brought by emerging market growth (globalization).

This report includes seven new megatrends. Some of these are entirely new topics. Others are new aspects of prior megatrends brought to the forefront by the continuing evolution of the primary forces.

## Future working worlds

Where are the megatrends headed? We argue that their combined effect leads to a broader reshaping of the political and economic landscape, which we analyze through three "**future working worlds**." The future working worlds describe the new rules by which various systems will be organized:

1. **Rebalanced global system:** the rules that govern the global order, driven by trends such as the rise of China
2. **Renewed social contracts:** the rules that societies and economies need to create a sustainable balance among the interests of citizens, workers, governments and companies

The report also highlights three megatrends carried forward from our previous report: **Future of work**, **Industry redefined** and **Health reimagined**. While they remain relevant, we've analyzed them here in less detail because they have now become the subject of much mainstream analysis.

Our list of megatrends is not exhaustive. Disruption continually spawns new ones at an ever faster rate as the primary forces evolve.

3. **Superfluid markets:** the rules that will organize future firms and markets as disruption eliminates market frictions

The future working worlds are broader in scope and occur on a longer time frame than the megatrends. While the megatrends disrupt large sectors (e.g. health and energy) or domains (e.g. consumers, cities and behavior), the future working worlds fundamentally reshape the entire political and economic landscape.

## Weak signals

Our analysis focuses mostly on the disruptions unleashed by the next waves of the primary forces (e.g. human augmentation, populism and aging). This is for good reason: it is these imminent disruptions that require the prime attention of leaders in the private and public sectors.

The **weak signals**, on the other hand, are waves of primary forces whose biggest impact is farther in the future. Their likelihood and the scale and nature of their impact are, therefore, subject to a greater degree of uncertainty.

For technology-driven weak signals, there is still considerable uncertainty, including basic scientific questions

that remain to be addressed. To address this uncertainty and prioritize among the weak signals, we sometimes follow the money. A weak signal may have tremendous scientific uncertainty; but, if it is attracting a good deal of “smart money,” we prioritize it for analysis.

Lastly, while weak signals may largely be driven by technology, they don't have to be exclusively so. They could emerge in the other primary forces as well.

We explore the weak signals in the **online edition**\* of our report. We will continue adding more in the months ahead.

## The upside of disruption

Disruption is not just a potential threat, it's also a latent opportunity. Indeed, we now see more companies looking for the **upside of disruption** – the all-important first step for transforming your business.

This raises an important question: what is the upside relative to? Planning for an uncertain future is all about picking the right baseline – which can recast an apparent downside as an upside.

For instance, relocating your plants and offices based on the trends discussed in **Remapping urbanization** may increase expenses and squeeze margins – an apparent downside. But, changing your baseline – to compare with the world that will exist in the future rather than the world as it exists today – illuminates

the potential upside in this strategy. **Rethinking your geographic footprint**<sup>†</sup> could yield huge savings as cities are reshaped by climate and technology.

Our framework provides an instrument for making such comparisons. It explicates where disruption is coming from, where it's headed and what it means for you. It can help you distinguish between the various kinds of forces at play and prioritize the ones that most require your focus. In doing so, it gives you the toolkit for developing the most relevant baseline for your future strategy.

In the months ahead, we will continue this discussion online with deeper dives into the megatrends. We invite you to join the conversation.

\* <http://ey.com/megatrends>

† [http://www.ey.com/Publication/vwLUAssets/ey-right-people-wrong-place/\\$FILE/ey-right-people-wrong-place.pdf](http://www.ey.com/Publication/vwLUAssets/ey-right-people-wrong-place/$FILE/ey-right-people-wrong-place.pdf)

# Primary forces:

The next waves



The three primary forces – technology, globalization and demographics – that are the root causes of disruption, have existed for millennia. While they are not new, they evolve in waves and the interaction among these new waves gives rise to new megatrends.

**In this section, we focus on one example of an emerging wave for each primary force:**

- ▶ The set of technologies that are collectively enabling the era of **human augmentation**
- ▶ The upsurge in **populism** that is fueling a backlash against globalization
- ▶ **Aging** populations that promise to reshape demographics across the world

**Technology: The next wave**

## Human augmentation

Technology has always augmented human capabilities. So far, this has been relatively passive: assisting humans in performing tasks. We are now on the cusp of human augmentation that is qualitatively different. For the first time, technology will take an active role, working alongside us and directly on our behalf.

The next wave of disruptive technologies, which are rapidly coming of age, are driving this change. They include AI, augmented reality (AR), virtual reality (VR), sensors and blockchain. These breakthroughs are in turn generating new products and services, such as AVs, drones, robots and wearables.

We are bombarded daily with more data than our brains can process. AI already acts as an intelligent consultant, helping us make sense of this cognitive burden, from curating reading lists to

navigating driving routes. Human augmentation technologies will soon assume even more agency as they drive cars, **automate jobs** (see Future of work) and make **retail purchases** (see Super consumer). In doing so, they will blur the line between humans and machines, realigning societal norms and challenging entrenched perceptions of ourselves.

Besides freeing us from mundane work, the combination of artificial and human intelligence could drive breakthrough discoveries. Human creativity and judgment augmented by the brute computational power of AI has already led to breakthroughs in **energy generation and storage**, **drug therapies for genetically caused diseases\*** and **space exploration<sup>†</sup>**. Next, it could yield solutions to some of humanity's most intractable problems.

\* <https://www.technologyreview.com/s/604305/an-ai-driven-genomics-company-is-turning-to-drugs/>

† <https://www.wired.com/story/new-kepler-exoplanet-90i-discovery-fueled-by-ai/>

But, to get these individual and societal benefits, we will not only need to broadly share our behaviors and data, but also reframe our relationship with technology. This raises difficult questions about autonomy, identity and privacy. Companies will need to carefully craft **behavioral design** of these systems to build customer adoption and loyalty. Governments will need new approaches to **regulation** (see adaptive regulation) to address issues such as algorithmic bias, transparency, consumer safety, inequality impacts and privacy.

What lies beyond could be even more transformative: a convergence of information technology, biotechnology and nanotechnology that promises to overhaul the very definition of what it means to be human. Neuroprosthetics, brain-machine interfaces, DNA editing, ingestible nanobots and embeddable radio-frequency identification (RFID) chips are still in labs. But, in the not-too-distant future, they may become tools that upgrade us from organic to bionic. We could find ourselves on an entirely new evolutionary path. The era of human augmentation is just beginning.



## Drones

What new challenges will drones create for regulators?

See ['Adaptive regulation'](#)

## Augmented reality glasses

How will brands engage with the AR-empowered super consumer of the future?

See ['Super consumer'](#)

## Brain-machine interfaces

How are human augmentation technologies such as BMIs challenging existing regulations?

See ['Adaptive regulation'](#)

## Smart clothes

How will healthcare diagnosis and delivery change when smart clothes replace today's wearables?

See ['Health reimagined'](#)

## Bionic eyes

When bionic eyes provide instant visual access to information, how will they change work?

See ['Future of work'](#)

## Exoskeletons

Will exoskeletons help human workers compete with robots in manufacturing?

See ['Future of work'](#)

## Autonomous vehicles

How will autonomous vehicles redefine cityscapes?

See ['Remapping urbanization'](#)

## Nanobots

How will nanobots change the role of the physician?

See ['Health reimagined'](#)



## Virtual personal assistants

When virtual assistants make buying decisions, how will companies need to think about branding and marketing?

See '[Super consumer](#)'

## Virtual reality experiences

What impact will VR have on where and how people work in the future?

See '[Molecular economy](#)'

## 3D Printing

How will 3D printing disrupt supply chains and business models?

See '[Molecular economy](#)'

## Home robots

Will we prefer home robots that look like humans or like machines?

See '[Behavioral design](#)'

## Enterprise robots

When robots become common at work, how will human workers' roles change?

See '[Future of work](#)'

## Populism

For the last seven decades, globalization has marched forward uninterrupted. The Bretton Woods Institutions and multiple subsequent free trade agreements ushered in an era of trade liberalization and global supply chains, trends that helped lift more than one billion people out of poverty.

In 2016, that inexorable forward-march hit a major roadblock when back-to-back election results gave us Brexit and President Trump, bringing populism and anti-globalization to the forefront. While populism had been ascendant in numerous countries before this – from Poland and Hungary to Bolivia and the Philippines – these elections brought such political philosophies to two of the world's largest economies.

After the US vote, major elections across Europe were nervously watched as populist parties gained new momentum. The results were mixed, with populists often performing better than they had historically, but failing to score outright victories.

These setbacks led some to predict that we are past “peak populism”, and that protectionist and nationalist forces are waning. But, it's too soon to draw broad conclusions from a few recent elections. Local parliamentary mechanics determine how populist parties play out from country to country, obscuring the overall trend. Electoral success may depend on whether victory requires majority or plurality, or whether power-sharing is winner-takes-all or proportional.

To better understand what's at play, we analyze the **primary forces** driving populism. Globalization and technology have collectively been disrupting jobs for decades. In the absence of adequate corrective measures from companies or governments, this has strained **social contracts** (see Renewed social contracts) and deepened economic inequality.

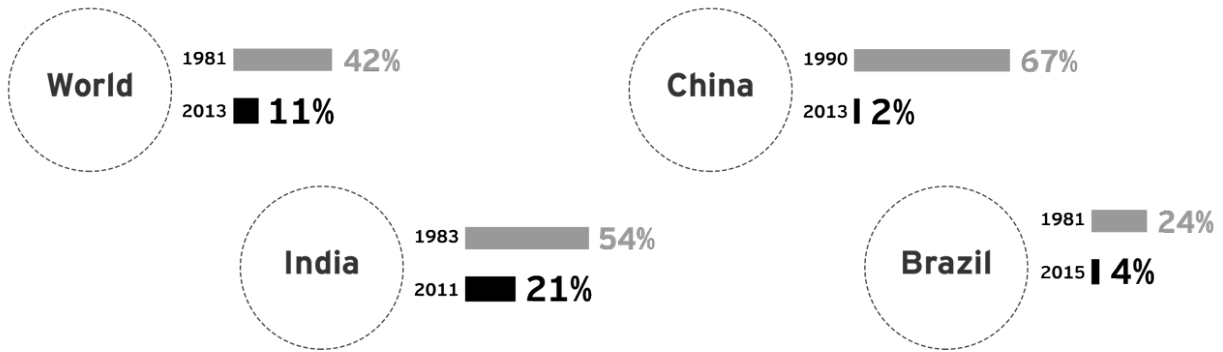
While globalization is a convenient scapegoat, technology is a bigger source of job disruption and inequality. This trend will only accelerate: automation and the **future of work** could lead to much greater job displacement and income inequality ahead.

For companies and governments, that should be a sobering outlook. So far, voters' displeasure has been directed at trade and immigration. If it turns next to automation and technology, most corporations would find themselves in the crosshairs. For leaders, a better path would be to proactively and collaboratively address the underlying sources of discontent.



## While globalization has helped lift more than a billion people out of poverty...

Share of population living on less than \$1.90 per day



Source: World Bank, World Development Indicators.

## ... it has increased income inequality within nations at every income level

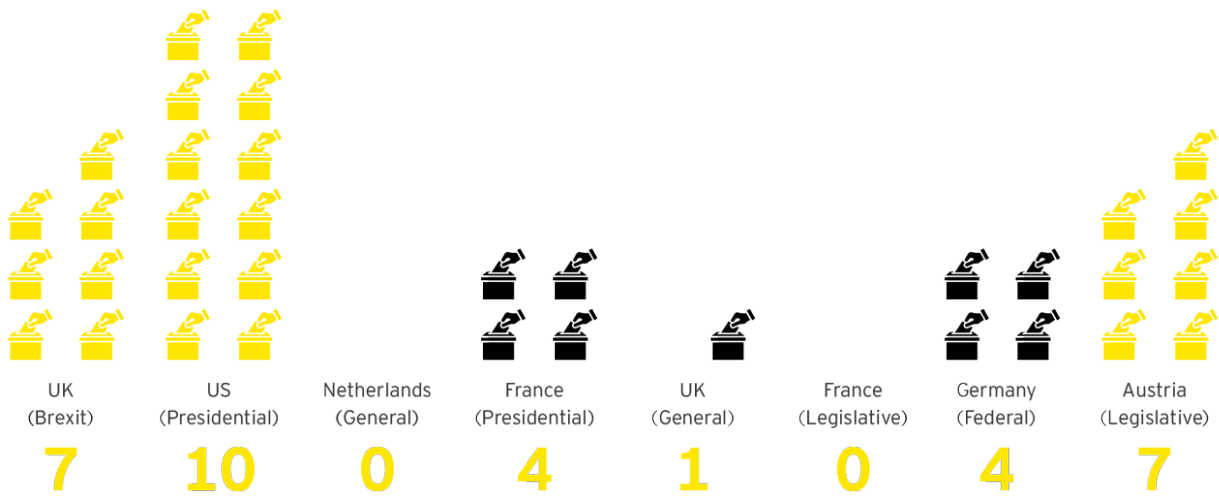
Gini coefficients



Source: EY calculations based on data from UN, Human Development Reports, extracted from EY's Growing Beyond Borders tool.

# Voters are turning against globalization, with mixed results

Populist performance score



**Source:** EY index calculated using media reports about select major elections in 2016 and 2017. The index is based on several factors, including whether the populist movement won or lost, its reshaping of the traditional (left vs. right) political landscape, and its electoral performance relative to expectations and prior performances.

## While globalization is the scapegoat, automation could produce more job disruption, with large numbers of jobs vulnerable in emerging markets

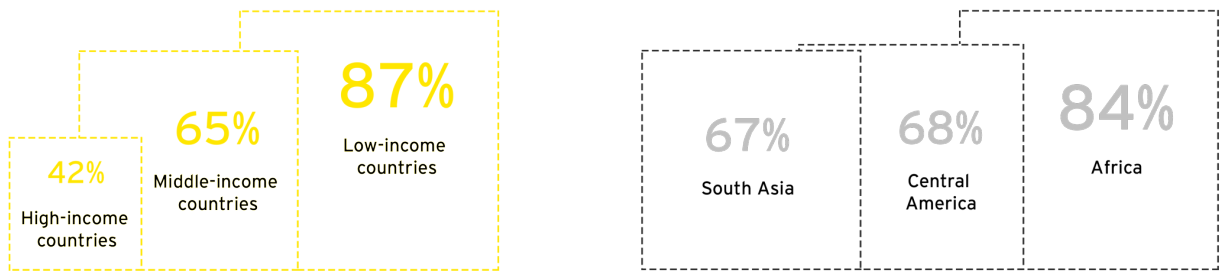
Share of jobs potentially at risk from automation



**Source:** Citi, Technology at Work, v. 2.0 and World Bank, World Development Report (2016). Chart shows selected emerging markets with jobs potentially at risk from automation.

# This could bring populism to more parts of the world. Employing largely young populations could be challenging in lower-income countries...

Share of population younger than 25



**Source:** EY calculations based on data from Oxford Economics, extracted from EY's Growing Beyond Borders tool. Chart shows continents/regions with the highest share of populations younger than 25.

... particularly in regions where  
unemployment is already high

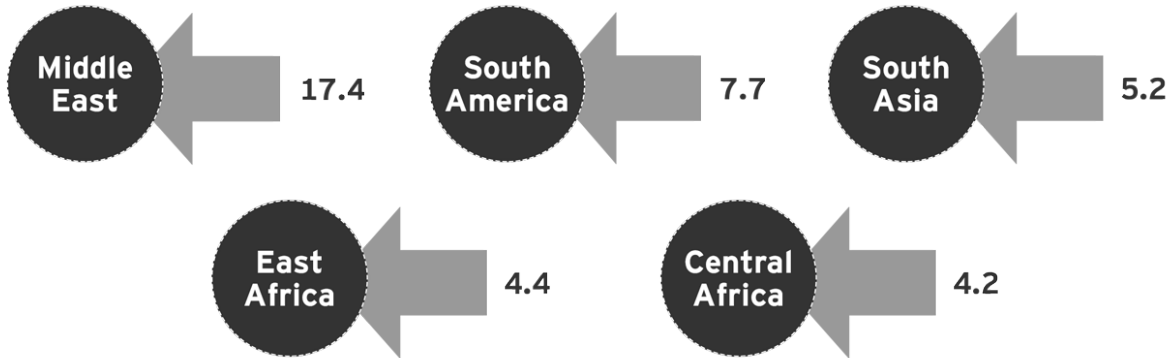
Unemployment rate



**Source:** EY calculations based on data from Oxford Economics, extracted from EY's Growing Beyond Borders tool. Chart shows continents/regions with the highest share of populations younger than 25.

## Meanwhile, growing refugee populations...

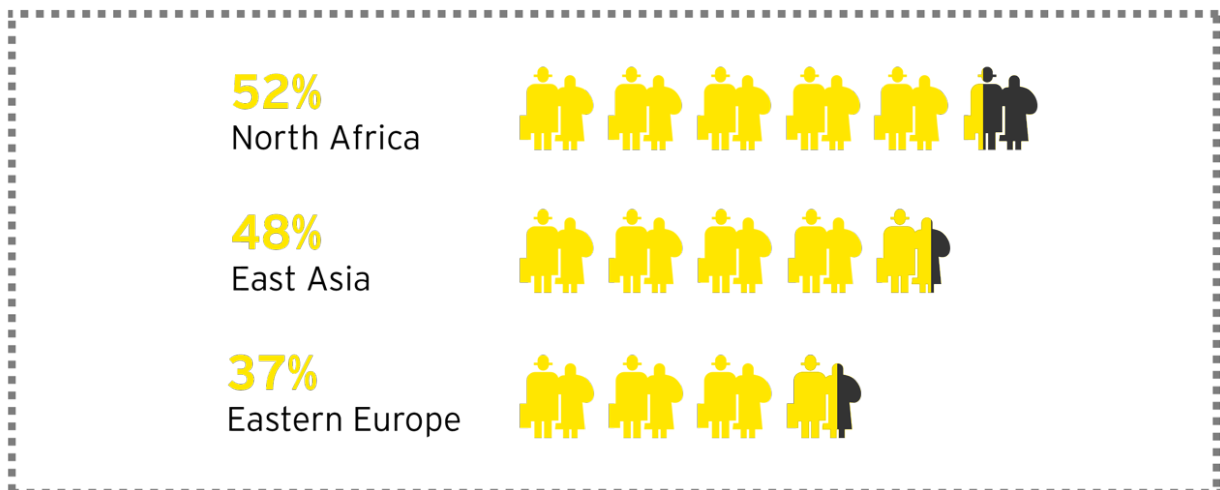
Refugees or displaced persons that have migrated to each country (millions)



**Source:** EY calculations based on data from United Nations High Commissioner for Refugees, extracted from EY's Growing Beyond Borders tool. Chart shows selected regions in which countries have taken in large numbers of refugees or displaced persons.

## ... could increase intolerance toward immigrants

Tolerance for immigrants (0 = low, 100 = high)



**Source:** EY calculations based on data from United Nations High Commissioner for Refugees, extracted from EY's Growing Beyond Borders tool. Chart shows regions with lowest scores for tolerance toward immigrants.

## Engaged aging

The world is getting older. Life expectancy has gone from 34 in 1913 to 67 at the turn of the millennium. By 2020, for the first time in human history, the world's population of people aged 65 and older will exceed the number of children under the age of five. And, the World Economic Forum estimates that the global cost of chronic diseases – driven largely by aging populations – will total **US\$47 trillion\*** between 2010 and 2030.

If demographics are destiny, it's not hard to read what those numbers imply for our collective future. Forget the millennials for a moment. The much bigger disruption is what's about to happen at the other end of the demographic distribution: aging populations across much of the world. These trends threaten to overwhelm health care and pension systems, draining public coffers and crowding out other societal priorities, from education to defense.

The good news is that while aging is inevitable, **how** we age is not.

Tackling the aging challenge – and seizing the latent opportunity it presents – will compel a fundamental change in societal attitudes, public policy and industry innovation. This is a shift that is already underway.

The future of aging is one in which technologies – sensors and apps now and, soon, algorithms, autonomous vehicles and robotic assistants – enable seniors to age independently. **Urban planners** (see Remapping urbanization), policymakers, health care providers and technology companies will need to team together to develop innovative solutions that allow people to age in place. Societies and individuals would benefit from reframing health not merely as the absence of disease, but as an asset that requires lifelong investment. Every individual could have a unique healthy aging profile that tracks physical, cognitive, social and material wellness.

With a shift this big, getting there is never easy – all the more so in a space as complex as this. Policymakers should align incentives to encourage disparate stakeholders to collaborate and accelerate the pace of innovation.

\* <http://apps.who.int/medicinedocs/documents/s18806en/s18806en.pdf>

Physical/cognitive wellness  
**Breakthrough drugs**

New drugs to tackle the diseases of aging.

See ['Health reimagined'](#)

Physical/cognitive wellness  
**Wearables and implantables**

Wearables and implantables to track various dimensions of health.

See ['Human augmentation'](#)

Social wellness  
**Autonomous vehicles**

New technologies and approaches to keep seniors mobile as they age.

See ['Remapping urbanization'](#)

Social wellness  
**Social engagement technologies**

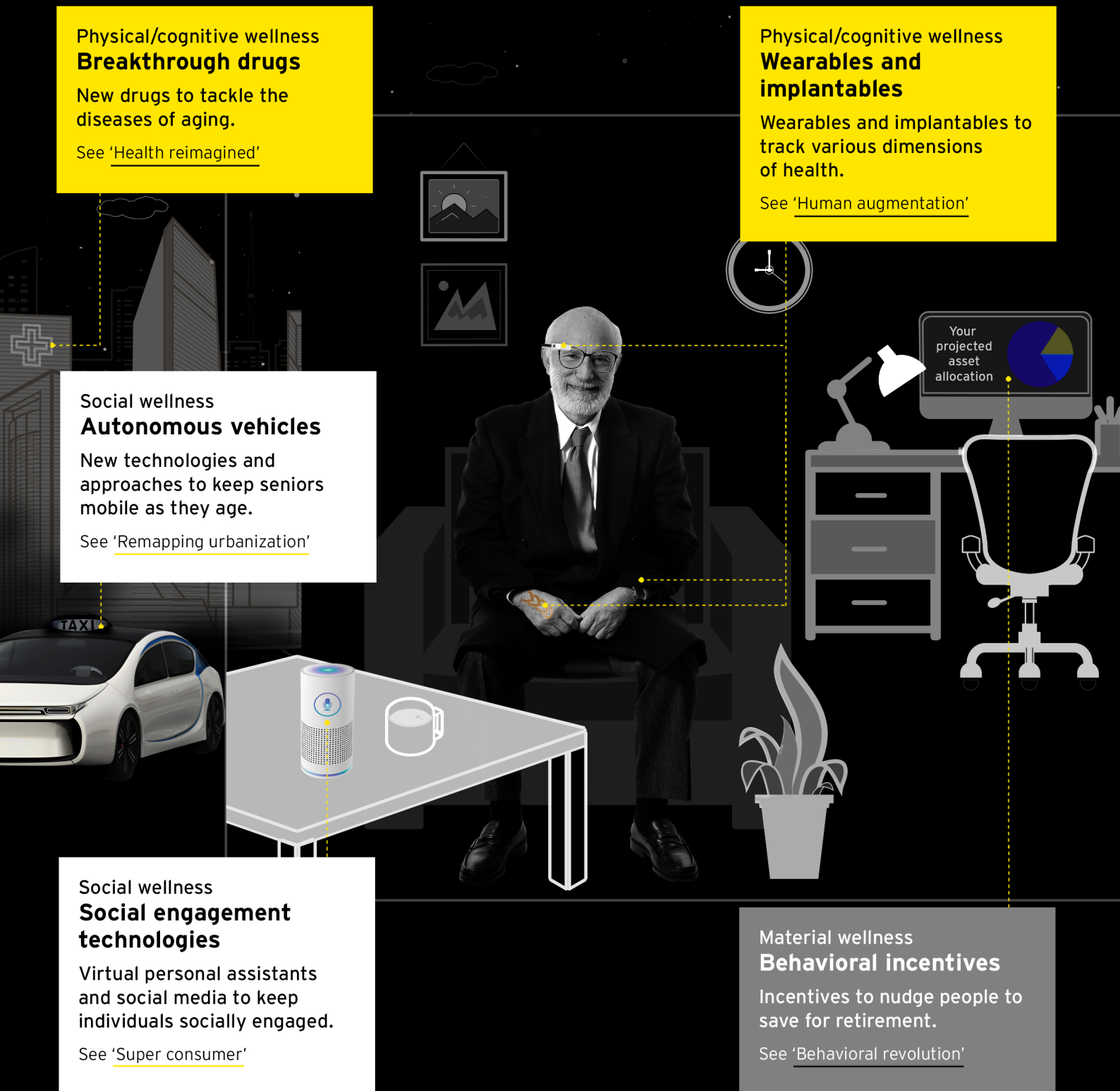
Virtual personal assistants and social media to keep individuals socially engaged.

See ['Super consumer'](#)

Material wellness  
**Behavioral incentives**

Incentives to nudge people to save for retirement.

See ['Behavioral revolution'](#)



Physical/cognitive wellness  
**Avatars**

Avatars to make aging tangible and motivate behavior.

See '[Human augmentation](#)'

Social wellness  
**Home robots**

Robotic caregivers to allow seniors to take care of their needs independently.

See '[Behavioral design](#)'

Social wellness  
**Sensors**

Smart homes embedded with sensors to empower seniors to age in place.

See '[Human augmentation](#)'

Material wellness  
**Rethinking retirement**

New ways of thinking about work and retirement.

See '[Future of work](#)'



# Megatrends





## Disruption

# Industry redefined

### Is every industry now your industry?

Industry – the concept and the reality – is being redefined and reinvented. In the pre-internet era, the competencies, assets and knowledge necessary to participate in any given industry sector were unique and varied significantly from industry to industry. Hard and fast industry boundaries (and high barriers to entry) arose as a result. With digital innovation and other forces acting as solvents, industry boundaries are melting and disappearing.

We see multiple ways in which the industry landscape is being redefined. Companies are accelerating their acquisitions of companies in other industries to enter different markets, develop new business models and expand their capabilities. Cross-industry alliances are forming. New value is being created at the intersection of old industry boundaries. Today's **convergence themes** (see The upside of disruption) include companies from different sectors coming together to deliver smarter cities, lifestyle-as-a-service and precision health.

What's happening here? Traditional industry hierarchies, once tidily codified in industry classification codes, are giving way to something more akin to "nodes" on an open industry network. Rather than discouraging new entrants, these nodes offer opportunities for companies from different industries

to come together, forming ecosystems. Each company brings distinctive perspectives, experiences and competencies to the ecosystem and what it is attempting to accomplish on the node. When new value is created, it benefits individual companies and the ecosystem as a whole. But, most importantly, entirely new fields of play emerge. And, these new fields of play do not fit neatly into any of the old industry categories. For example, automotive manufacturing, energy, technology, media and consumer products companies are coming together not just to reimagine the car as a product, but also to reimagine how we will move goods and people in the future. What was once narrowly thought of as the automotive industry is being redefined in the context of a much larger mobility opportunity.

As companies explore new opportunity nodes, they become harder to categorize from a traditional industry perspective. For example, is Amazon a retail, technology, logistics or a grocery company? It is all of them and perhaps more. But, does it matter? What's important is that digital innovation has leveled many of the old constraints associated with discrete and hierarchical industry categories. With digital fluency, good strategies and new business models as tickets to participation, today's companies can play anywhere and everywhere, redefining industries in the process.



## Questions

As industry walls dissolve, what are the new barriers to entry?

As others converge on your industry, what new ecosystems will emerge?

When industry walls collapse, will you play offense or defense?

How does competition change when your rivals become your collaborators?

How are you exploring new business models in light of competitive changes to your industry?

How is your organization preparing to engage in more alliances and partnerships?

# Future of work

## When machines become workers, what is the human role?

When EY first wrote about the **future of work**\* in our 2016 Megatrends report, the topic was just starting to attract attention. Skeptics doubted predictions about massive disruptions of labor by AI and robots.

Now, we are overwhelmed with analyses of the future of work from the mainstream press, business literature and consultants. Predictions that seemed distant two years ago are entering the real world – from the live-testing of autonomous ride-sharing in key cities to the opening of the world’s first fully automated retail outlet, the Amazon Go store in Seattle.

Our analysis of the future of work now spans these aspects:

- ▶ **More than technology:** We are exploring how work is being re-invented, not just by technology, but also by demographic factors (e.g., millennial workers) and cultural drivers.
- ▶ **Social contracts and public policy:** The changing nature of work is upending **social contracts** (see renewed social contracts), for example, by widening inequality and undermining aspects of social contracts tied to the employer-employee relationship, from retirement savings to workplace protections. This will require new public policy solutions.

- ▶ **Learning and education:** Preparing workers for the future of work will take a very different approach to education, emphasizing skills over knowledge and lifelong learning over front-loaded educational systems.
- ▶ **Leadership response:** Perhaps the biggest shift over the last couple of years has been how leaders in the private and public sector are taking active measures to prepare for the future of work. Companies are revamping their approaches to human resources and talent, employee motivation, recruiting, training and skills development. Policymakers are exploring new solutions, from regulatory responses to new safety net solution, such as a universal basic income.

Much of the content in the other sections of this report flows from the “future of work” megatrend. What we were talking about when we began this analysis – though we didn’t yet have a name for it – was human augmentation. Since we were examining technologies that could autonomously perform human work, it was only natural to start by considering their most immediate impact: work. Two years later, a fuller range of implications is coming into view, from the impact on **consumers** (see Super consumer) to **human behavior** (see Behavioral design) to **regulation** (see Adaptive regulation). The future of work is really about the future of humankind – and we are just starting to understand the breadth of its impact.

\* <http://www.ey.com/gl/en/issues/business-environment/ey-megatrends-future-of-work>



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## Questions

How will machines and humans partner to do what each of them does best?

What can business and governmental leaders do to enable this?

How do we teach people to learn how to learn?

Do your people have the skills they need to work alongside robots and algorithms?

What responsibility do businesses and governments have for preparing workers for the era of automation?

What is the future of retirement?

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## Super consumer

### When humans are augmented by AI, who gains the most – consumers or brands?

Technology will assist future consumers across all aspects of their lives. Here's a plausible scenario:

Pari awakens in London to the smell of waffles hot from the kitchen 3-D printer. Her virtual personal assistant, Martin, says good morning and mentions that it's cold outside. He tells her that he's purchased the sweater she's been admiring and it has just been drone-delivered. After Pari gets dressed, her driverless taxi arrives. During the commute, Pari enjoys a VR call with her husband, who is traveling overseas. When Pari arrives at her shared office space, she is notified that three different companies have requisitioned the services of the freelance collective to which she belongs. One request originated in China and has already been translated. On her way home after work, Pari's implanted microchip alerts Martin to a high cholesterol reading. Martin announces that he has booked an appointment with a virtual doctor and has preemptively revised her menu plan. That evening at home, Martin ports Pari into her favorite VR video game. Later, as she goes to bed, Martin plays a soothing soundtrack. The songs have been composed by an agent that understands Pari's musical tastes and current emotional state. As Pari sleeps, Martin plans her next vacation.

We expect the evolution and interplay of AI, machine learning, ever-present sensors, smart devices and new computing interfaces to take consumer empowerment to a whole new level – giving rise to tomorrow's super consumer. A little like the fictional superheroes of comic books, super consumers can be defined as those who embrace new technologies, such as AI, VR, wearables and robotics, to create smarter and more powerful extensions of themselves. Whether working, playing, eating, shopping, learning or pursuing healthier lifestyles, tomorrow's super consumers will be **augmented by technology** (see Human augmentation) in the service of achieving more informed and rich experiences across these different categories of living.

## We can now discern a vision of tomorrow's super consumer

Super consumers will communicate with markets, companies, governments and each other in a very different environment than exists today.

- ▶ **Voice will drive interactions.** Super consumers will be largely liberated from keyboards, screens, taps and swipes. While text will still have a place, voice will be the predominant means of future interaction among consumers and companies, given that it is a natural and faster communication mode for human beings.
- ▶ **Machines will augment human decision-making.** Virtual digital assistants will play multiple roles in people's personal and professional lives as concierges, executive assistants, coaches and the like. Imbued with emotional awareness, these assistants will know their human owners profoundly as individuals and will make decisions on behalf of those they serve.
- ▶ **Access to technology will be ever-present.** Enabled by an invisible and unobtrusive internet of things (IoT), consumers will be surrounded by intelligent physical environments that are sensitive and responsive to their needs and desires. Wherever consumers happen to be, they will have access to the technology required to execute their demands. Disparate environments (homes, cars, stores and work spaces) and operating systems will be bound together in seamless fashion. As consumers crisscross and inhabit various spaces, these spaces will recognize and interact with them in personalized and contextual ways, sometimes assisted by AR capabilities.

## Today's consumers are steeped in the art of the possible

Today's consumers are daily overwhelmed with the vision of this more **frictionless future** (see Superfluid markets). Their expectations are already high and rising. Today's **empowered customers**\* already expect their brand experiences to be unified and elegant across all touch-points. They want to be recognized as individuals, have their likes and dislikes understood and remembered, receive advice perfectly aligned to their interests, and receive

highly personalized products and services. They expect technology to help, not hinder, their quest to get what they want, and where and when they want it. And, the price of a mistake is high. Forrester reports that consumers who experience disgust, anger or a feeling of neglect during negative brand interactions are eight times more likely **not to forgive**† that company than those who experience other forms of poor interaction.

\* <http://www.ey.com/gl/en/issues/business-environment/ey-megatrends-empowered-customer>

† <https://go.forrester.com/wp-content/uploads/Forrester-2017-Predictions.pdf>

## There are challenges and complexities to realizing the super consumer vision

While consumers' expectations are high, reality lags behind. Some of the mismatch is technology-related. Today's AI is good at performing narrowly defined tasks but less adept at completing generalized intelligence tasks that require human-like reasoning. The multitude of "smart" devices and systems on the market cannot interoperate. Quantum computing is immature and cannot, at present, meet the massive demand for additional processing power that increased data flows and sophisticated algorithms will require.

The fast pace of change creates other challenges. Consumer interfaces and channels are proliferating. Companies struggle with where to make their investments for the future while executing on the basics today.

The rise of the super consumer will be a worldwide phenomenon, but could play out at different speeds and levels of complexity across the world. AI investment and adoption has increased dramatically in both **China and India**\* over the past few years, suggesting that Asia might well lead the way in terms of generating new super consumers. At the same time, persistent economic inequality and infrastructure disparities across the globe, and within nations themselves, could lead to a class of disempowered consumers who fail to benefit from the AI revolution.

In Europe and the US, concerns about privacy and the ownership of one's personal data are more than just a rumble, especially amid stories about high-profile data breaches, fears of government abuse of personal data and tales of personal virtual assistants spying on their owners. Will consumers continue to relinquish control of their data to providers in exchange for free services? Or, will part of becoming a super consumer involve monetizing one's own personal information? Generational differences may blunt some of these concerns. After all, digital natives have grown up in an environment where personal data is readily exchanged for convenient services and unique experiences.

And, empowerment may not look as it does now. With the arrival of the Internet, consumers became directors of their own lives while sitting at keyboards and tapping on phones. It's a different kind of empowerment when people opt to become passive as computers make decisions for them. Some consumers may resist becoming "owned" by one of the emerging AI ecosystems or delegating decisions to these ecosystems. (For more on these behavioral challenges, see "**Behavioral design**".)

\* [http://www.business-standard.com/article/technology/indian-chinese-firms-top-ai-investment-adoption-in-asia-forrester-study-118022100223\\_1.html](http://www.business-standard.com/article/technology/indian-chinese-firms-top-ai-investment-adoption-in-asia-forrester-study-118022100223_1.html)

## **Companies must do the work now to close the expectation gap**

Rising expectations put the onus on companies to innovate now with tomorrow's super consumer in mind. Seamless delivery of pleasing experiences across physical and digital realms, as well as disparate channels and devices, is the goal. Reaching the goal will require the right mix of new technology investments, especially those that will yield valuable data on current and prospective consumers.

Beyond determining the right mix of technology investments, companies must also re-engineer business processes and operations to achieve a holistic view of the consumer across the entire brand journey. Companies must connect fragmented technologies and data silos as part of this effort. The ecosystem of data providers and agencies that support marketing should also be integrated. But, ultimately, companies that thoughtfully consider what it means to be human in an intelligent machine era will create the brands that attract super consumers. Humans are verbal and conversational, as well as emotionally driven. From their providers, they want relevant and trusted interactions, frictionless transactions and rich experiences. The companies that can leverage technology and design experiences to meet these criteria will be best positioned to serve tomorrow's super consumer.





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## Questions

What will it take for intelligent machines to gain the full trust of consumers?

Can intelligent machines help consumers make more intelligent decisions?

Does trading data for services have to be a zero-sum game?

When AI makes the buying decisions, how will you get your brand noticed?

What steps will you take today to deliver optimal consumer experiences tomorrow?

Do you have a dual strategy – one for today's customers and one for tomorrow's customers?

## Behavioral design

### How will insights from psychology improve the partnership between humans and new technologies?

The relationship between design and behavior has never been more important than in the era of **human augmentation**

This link has been increasingly visible in recent years. The launch of Google Glass fizzled partly because of people's fears of being surreptitiously recorded. Smartphone and social media addictions are rising because manufacturers have designed for irresistibility.

Understanding how design motivates behavior will become even more important with human augmentation. As AI, robots and other technologies become increasingly lifelike and enter spaces that have so far been exclusively in the human domain, they will trigger deep-seated human biases. Leaders must attend to the implications of behavioral design for everything, from **customer engagement** (see Super consumer) to fears about automation to the outcome of elections.

### Social and mobile are driving a behavioral revolution

In recent years, two trends have moved the discipline of behavioral economics, which identifies behavioral biases in human economic behavior, from the corridors of academia to mainstream market application.

Firstly, many societal challenges aggravated by behavior – climate change, chronic diseases and excessive debt – are becoming increasingly urgent and expensive. Secondly, mobile and social platforms are making it possible to measure and guide behaviors in real-world, real-time conditions like never before. (For more, see "**Behavioral revolution\***" in our 2016 **Megatrends<sup>†</sup>** report.)

### Human augmentation will supercharge the behavioral revolution

The next wave of technological disruption, human augmentation, will raise this challenge to a whole new level. While mobile and social

platforms have been transformative in changing behavior in real-time and real-world conditions, they still rely on human intervention.

\* <http://www.ey.com/gl/en/issues/business-environment/ey-megatrends-behavioral-revolution>

† <http://www.ey.com/gl/en/issues/business-environment/ey-megatrends>

Human augmentation technologies promise to change that. Today, individuals managing their diet may need to constantly remember to enter meal details and calories in an app. In the future, AR could eliminate this step as smart eyeglasses and smart dishes automatically identify and capture meal data, enabling motivational “nudges” based on more accurate and complete real-world information. AI could enable personalization to a degree

never before possible. AVs and future mobility options could drive more efficient use of natural resources. “Digital twin” avatars could show individuals the long-term consequences of their health decisions.

Achieving this vision would deliver significant benefits to society by addressing expensive societal challenges. It would also profit companies by boosting customer engagement and loyalty.

## **Behavioral design will become a key focus**

Getting to this optimistic future will require tremendous focus on behavioral design: designing products, features, interfaces and messaging that account for the cognitive

biases that human augmentation technologies are likely to trigger. Behavioral economics offers some insights for companies.

### **We are predisposed to fear new technologies**

Human augmentation is sparking fears about everything, from job losses to AV safety to the prospect of self-aware AI that threatens humanity. While every new technology creates some risks, several cognitive biases predispose humans to overestimate such threats.

The availability heuristic leads people to focus on and exaggerate the importance of readily available information. So, the barrage of news coverage about a single Tesla crash while in automated mode drowns out a sea of underlying data about AV safety.

Probability neglect leads us to focus on the magnitude of outcomes (e.g. dying in a car crash) rather than their associated probabilities (e.g. automated vehicles are statistically safer than human drivers). To the extent we process probabilities, we tend to overestimate small chances.

AI and AVs are already triggering such fears. We expect more as technologies such as passenger drones and brain-machine interfaces come into their own.

## Control is important

The illusion of control bias predisposes us to want to feel that we have control even in situations where we don't. The "door close" button in many elevators, for instance, does not affect how soon elevator doors shut; it merely gives users a sense of control.

This aspect of human psychology will become increasingly relevant as human augmentation technologies start acting on our behalf.

For instance, AVs could, in theory, enable a complete redesign of automotive cabins to look more like living rooms, but the need for control might instead dictate retaining steering wheels and brake pedals. Similarly, **virtual shopping assistants** (see Super consumer) could reinvent the shopping experience, but it's not yet clear whether consumers will be comfortable with surrendering control over their purchasing decisions.

## Lifelike interfaces trigger human psychology

As AI assistants, robots and VR become increasingly lifelike, they could trigger cognitive biases. Designers will need to keep this in mind.

We have a deep-seated tendency to **anthropomorphize** (attribute human-like qualities to) inanimate objects. Designers have long used this tendency, for example, with car grills that subtly evoke a human mouth. Robots and AI assistants will take anthropomorphism bias to a whole new level, with implications for user adoption and engagement.

Anthropomorphic design insights are already emerging. For instance, **studies find\*** that digital assistants are more likeable if they make small mistakes instead of operating flawlessly – a result known as the **pratfall effect**.

Another bias, the **uncanny valley**, leads people to feel repulsed by robots or VR implementations that appear almost, but not quite, human. This suggests that developers might keep products from becoming too lifelike in the short run. (The repulsion effect may disappear once designs become indistinguishably lifelike).

Our tendency to anthropomorphize also raises concerns that our behaviors with lifelike machines might influence how we behave with other humans. Will the license to behave cruelly toward a robot desensitize us in the way we treat each other? On issues like this, design may need to be augmented by **regulation** (see Adaptive regulation).

\* <https://www.frontiersin.org/articles/10.3389/frobt.2017.00021/full>

# Behavioral design principles for the human augmentation era

We expect these behavioral design principles to become commonplace:

1. **Designing for cognitive biases:** Behavioral economics will inform successful design for human augmentation technologies. Designers may need to include design elements that provide choice and user control, for example. Marketers could frame these designs by emphasizing what users lose by failing to adopt new technologies (leveraging the bias of **loss aversion**). Similarly, they could incorporate messaging on adoption rates by others in the community to encourage uptake (**social norms**).
2. **Differentiating for social contexts:** Since users endow anthropomorphic products with human-like attributes, these products exist in specific social contexts. Developers will need to design differently for each context. For instance, users might prefer that home care robots assisting them with bathing be less lifelike than those helping them with financial planning. Chinese users view privacy and control differently from those in Europe. Different generations will bring different levels of acceptance to their adoption of new technologies.
3. **Learning based on the stages of adoption:** Since human augmentation technologies are a new space, companies will continuously adapt designs and incorporate the lessons they learn. Indeed, user biases themselves will change at different stages of the adoption curve. Fears of technology and the need for human control could dissipate with time; designs will adapt. On the other hand, other cognitive biases will become more important with time. One example is **automation bias**, which is the tendency to rely excessively on automation over human judgment.



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## Questions

Do you understand your customers' behavioral barriers to adopting innovation?

How are you incorporating behavioral design in products, services, interfaces and messaging?

How could we design technology to be less addictive and polarizing?

Would you trust an autonomous vehicle with no steering wheel or brake pedal?

How could augmented and virtual reality nudge our real-world behaviors?

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## Adaptive regulation

### How could regulation be responsive to rapid change and an unknowable future?

Regulation can be a contentious issue. Critics argue – often justifiably so – that it is onerous, inefficient and an impediment to innovation. But, imagine an entirely different approach. Imagine a future in which consumer safety is protected not by monitoring regulatory compliance and penalizing infractions, but by using big data and algorithms to prevent breaches before they can even occur. Imagine regulations that rewrite themselves to keep up with ever-changing market conditions. Imagine regulation conducted jointly by industry and regulators – a collaborative, rather than contentious, exercise. This is where things are headed. The future of regulation is adaptive.

The reason for this shift is disruptive innovation. On one hand, disruptive technologies and business models are straining existing regulatory approaches and making them unsustainable. On the other, these technologies are creating opportunities to conduct regulation in an entirely new way.

### Regulation is a vital part of social contracts

Regulation serves a vital purpose, making it a key part of any **social contract** (see Renewed social contracts) It ostensibly seeks to protect the interests of less powerful constituents (e.g., consumers, workers and small businesses) from the excesses of more powerful institutions.

Disruptive innovation challenges regulatory frameworks. It forces regulators to reconsider and recalibrate the delicate balance that regulations strike between the competing interests of different constituents. And, it creates entirely new entities and business models that existing regulations – often written decades earlier – could never have foreseen.

## Sharing economy platforms are already challenging regulators

So far, these tensions have been most visible in the sharing economy, where regulators are confronting unprecedented questions. Are drivers on a ride-sharing platform contractors or employees? Are they subject to the scores of rights and protections – from minimum wages to retirement savings – that have traditionally been built around the employer-employee relationship? What responsibility do platform companies have for ensuring tax compliance? How do regulators apply hotel safety regulations to a shared lodging platform on which everyday citizens with spare bedrooms are part-time hoteliers?

Since sharing platforms provide services with a strong local component, these issues are being addressed primarily by city and state regulators. So far, we've seen conflicts, fought one jurisdiction at a time, along with a wide variance in regulatory approaches.

But, authorities are also starting to address these issues at a broader level. In November 2017, for instance, the European Court of Justice ruled that Uber is a taxi company, rather than just an online platform for connecting riders and drivers, a finding with EU-wide implications. Next, human augmentation technologies will raise bigger and more fundamental regulatory issues, bringing them to the national and international stages.

## Human augmentation will bring these strains to a breaking point

The era of **human augmentation** will raise unprecedented regulatory challenges, necessitating skills well outside regulators' traditional competencies.

Instead of licensing human drivers, regulators may need to certify and monitor algorithms – a task that demands a completely different set of capabilities. AVs will require new rules and infrastructure, from air lanes for drones to sensor-embedded highways for driverless trucks. AI will raise an array of regulatory challenges,

from ethical issues to the certification of transparency and lack of bias in algorithms. Ever-present sensors and digital assistants will make privacy and data security concerns even more pressing.

And, these are just the issues we can **foresee**. If regulators must fundamentally retool to adapt to AVs, just imagine the regulatory challenges that a more profoundly disruptive technology, such as brain-machine interfaces, might raise.



## The answer is adaptive regulation

So far, we've discussed how regulations need to adapt to changing market realities. But, trying to keep up is ultimately a losing game. As the pace of disruption keeps increasing, regulators at some point may find themselves creating new regulations that become obsolete almost as soon as they are passed.

We will, therefore, need to move from **adapting** regulations to **adaptive** regulation – a fundamentally different approach that is more nimble and responsive to changing market realities. What if we could turn the approach on its head: not regulation **of** disruptive technologies, but regulation **by** disruptive technologies?

This move to adaptive regulation is already underway, albeit still in its early days. It involves developing approaches that are **open, real-time** and **dynamic**.

**Open:** To appreciate the potential of open regulation, consider the open data and open government movements. Inspired by open-source software, these movements argue that government data, created using taxpayer money, is a public good that belongs in the public domain. A growing number of governments, from Singapore to Boston, are now sharing data with the public in machine-readable formats. This has increased transparency and accountability – while enabling an ecosystem of creative third-party apps and websites that provide services well beyond what governments had traditionally delivered. For instance,

Rentlogic provides renters with letter grades on New York City landlords using open government data on building code violations.

Open regulation would expand these approaches. One could imagine supplementing the growing pool of open government data, with open data reported by companies and open data from the IoT. This would provide a solid foundation for more real-time, dynamic regulation built using technology and crowdsourcing.

**Real-time:** Recent years have seen an explosion of regulatory technology (RegTech) companies that apply technology to automate regulatory reporting and compliance. These approaches have emerged primarily in financial services where compliance costs skyrocketed in the aftermath of the global financial crisis.

While RegTech may have emerged to cut costs, its marriage of technology and regulation also paves the way for real-time approaches to regulation. For instance, numerous firms are applying sentiment analysis algorithms to a wide range of data – voice mails, emails, chat messages, expense reports, Global Positioning System (GPS) data and the like – to identify fraud, corruption, insider trading and other violations. Meanwhile, companies in the oil and rail transportation sectors are using sensor data for preventive maintenance, flagging and proactively fixing potential safety issues.

Such methods could be applied more broadly as AI grows increasingly sophisticated and the volume of open, real-time data explodes. This would be a fundamentally different approach to regulation. The slow, sequential process of collecting data, reporting, monitoring compliance and penalizing infractions would be replaced by techniques that are real-time and preventive. This would have significant implications for corporate functions, processes and competencies, and will disrupt the armies of middlemen, from lawyers to auditors, who owe their existence to traditional ways of conducting regulation.

**Dynamic:** In addition to being open and real-time, a truly adaptive regulatory approach would also respond dynamically to changing market conditions. We will probably never reach a point where AI will write or rework regulations on its own – as with automation in every other sphere, humans' ability to apply context and nuance will remain pivotal. But, it is not too far-fetched to imagine algorithms analyzing data and identifying gaps where existing approaches are not keeping up with market realities.

Getting there will not be easy. While some regulators are encouraging experimentation through "sandboxes," regulators (and corporate compliance departments) are generally risk averse and slow to change. Applying open data on a large scale must still allow companies to protect proprietary or competitive information. Regulators will need to develop safeguards to mitigate the risk of unforeseen outcomes from algorithms that behave and evolve in unpredictable ways.

But, the potential benefits are tremendous. Regulation imposes significant costs on businesses and society. Approaches that are both more effective and less expensive should be welcome news for businesses and taxpayers alike.



## Questions

In a world of AI and crowdsourcing, should regulation only be done by regulators?

Could regulation become predictive instead of prescriptive?

When algorithms manage our lives, who will manage the algorithms?

How aligned is regulation in your sector for the disruptions that lie ahead?

What new competencies will regulators need to respond to disruption  
in your sector?

How are you engaging in the conversation to develop new regulatory approaches?

## Cities

# Remapping urbanization

### How will cities be reshaped by technology and our greatest challenges?

The urbanization of the future could look fundamentally different. Two sets of forces will converge to alter where we build and how we build:

1. How cities respond to sustainability challenges, such as climate change, chronic diseases, aging and affordability

2. How disruptive technologies that are transforming transportation and reinventing work reshape urban centers

## Sustainability challenges will remake the urban landscape

Climate change and evolving population demographics will create major shifts, much as mass transit and cars did in an earlier era.

### Climate change and sea-level rise will transform the shape of cities

We often think of climate change in terms of long-term effects: warming temperatures and rising sea levels that will alter the environment and reshape civilization. The urban environment is particularly vulnerable because half of humanity lives on 1% of the land and cities grew up near waterways and oceans. While **areas threatened by sea-level rise\*** represent only 2% of the world's land, they cover 13% of the world's urban population – and 21% of the urban population of developing countries.

Climate change is already having very real effects that are challenging the direction of urban planning. Jakarta is sinking rapidly and could be underwater within a decade. Cape Town is about to become the

first major city to run out of water. Climate change is increasing the destructiveness of extreme weather events: hurricanes (or typhoons), rainstorms, blizzards, forest fires and droughts.

These contingencies have profound implications for urbanization patterns. Urban planners are fundamentally rethinking their traditional approaches because they aggravate flooding. The vast majority of the urban footprint – buildings, roads, driveways and parking lots – uses impermeable materials that prevent water from being absorbed. The problem has compounded as cities, from Houston to Kolkata, have expanded into neighboring plains and wetlands to house soaring populations.

\* <http://journals.sagepub.com/doi/abs/10.1177/0956247807076960>

To make cities more resilient to extreme weather, urbanization patterns are starting to shift. Planners are realizing that infrastructure needs to be built differently, with extensive use of permeable pavement and more green spaces in the form of parks, ponds and green roofs. Planners must rethink or relocate urban development in vulnerable locations. As many cities take steps in this direction, China is leading the way with its “Sponge Cities” initiative, which has been deploying these tactics on an unprecedented scale since 2013 – initially in 16 cities, with plans to eventually take the approach nationwide.

Cities are also starting to plan for the long-term effects of sea-level rise, which promise to be even more disruptive. A global survey of 350 cities\* conducted by Massachusetts Institute of Technology (MIT) found that 75% of cities have plans to mitigate and adapt to climate change; but, 78% said that a lack of funding for implementation is a significant challenge.

### Public health and urbanization have a complex relationship

In some ways, city living can be harmful: researchers have found<sup>†</sup> that levels of air pollution in Chinese cities are highly correlated with mortality rates. But, other studies<sup>‡</sup> find that increased urban density – more housing units per square kilometer, greater intersection density and narrower roads with fewer lanes – is associated with lower levels of obesity, diabetes, hypertension and heart disease.

To combat chronic diseases, urban planners and employers have been taking steps to encourage active urban lifestyles, from city bike programs to employer wellness plans. Meanwhile, smart urban design is empowering seniors to age independently and actively. The question is what effect other disruptive trends will have on urban public health. For that, we turn next to the impact of disruptive technologies.

## Disruptive technologies will reinvent mobility within cities

How people get around cities – for work or other purposes – shapes the way those cities grow. So, profound changes in mobility and work will reshape the future urban landscape.

\* <https://www.preventionweb.net/publications/view/38666>

† <https://www.sciencedaily.com/releases/2017/11/171106100658.htm>

‡ <https://www.sciencedaily.com/releases/2014/08/140811125153.htm>

## The future of mobility

Three disruptive technologies – ride-sharing platforms, AVs and electric vehicles (EVs) – will collectively transform the future of cities. (We discuss more uncertain future technologies, such as passenger drones and Hyperloop, in the section on **weak signals**.) Much as the disruption of the retail sector is leading to the repurposing of shopping malls and warehouses, the future of mobility will spur new uses for roads, traffic lanes, parking garages and more.

To understand where things are headed, consider the impact of ride-sharing platforms. The average car sits unused 95% of the time. Even when in use, most cars have underutilized capacity in the form of vacant seats. Ride sharing is squeezing these inefficiencies out of the system by combining data, algorithms and creative business models to deploy transportation assets more efficiently.

AVs will take this to the next level. An AV, unlike a human-driven vehicle, can remain in operation around the clock, mitigating the 95% underutilization and reducing the need for so many vehicles.

This, in turn, suggests dramatically lower traffic congestion and a significant reduction in the urban footprint devoted to vehicles. Roads and traffic lanes could be landscaped into “bioswales” for floodwater remediation. Parking lots could be transformed into green spaces and micro-housing. Parking garages could be repurposed as environmentally sustainable **urban farms** (see Food by design).

EVs might similarly reshape urban infrastructure. Filling and service stations could be repurposed because EVs need much less servicing than internal combustion vehicles and will likely be recharged at parking spots. EVs would also generate huge public health benefits by reducing pollution, which is one reason why China is pushing their adoption in a big way.

AVs may even transform the very role of the car. Instead of just providing transportation, cars could be redesigned to fulfill other needs, such as sleep or entertainment, with appropriate **behavioral design**. This would make long commutes painless, leading to lower urban density and a rebalancing of population away from city centers.

Urban planners are already worrying about public health implications. A future in which transportation is effortlessly available on demand could spur more sedentary lifestyles (although it would be a boon for senior citizens). Expect policymakers to respond with behavioral nudges to counter this trend. For instance, increased congestion pricing, tolls or other traffic-based levies could compensate for lost gasoline tax revenues while also discouraging sedentary lifestyles.

## The future of work

Automation and shifts in demographics are shaping the **future of work**.

Work is becoming unbundled from physical location. The growing popularity of remote work and co-working spaces is challenging the long-standing norm of the traditional office. As more individuals become entrepreneurs and gig workers rather than full-time employees, the need to be located close to an employer will diminish. AR and VR promise to further enable virtual work.

This is a momentous shift. Today, proximity to work is one of the biggest factors determining where people live – whether it's tech workers moving to San Francisco or villagers flocking to teeming megacities in developing countries, in search of employment.

Proximity to schools, health care, restaurants and cultural activities also shape location decisions. But, these factors will eventually follow the shifts in population and economic activity that come from changes in where and how people work.

The increasingly virtual nature of work, combined with the future of mobility, could, therefore, reduce the pressure to locate in megacities, leading to a more balanced approach to urbanization and development – particularly if policymakers make concerted efforts to bring populations in developing countries online. This should be good news for both large metropolises straining to grow sustainably and second-tier cities struggling to remain competitive. We explore this further in our **“Innovating communities”** megatrend.

## The future of cities is not more of the same

Urbanization forecasts often focus on quantity: a future with more cities, more residents and bigger metropolises. But, the trends discussed here emphasize that the future is not a linear extrapolation from the past. The interaction of megatrends and primary forces will fundamentally reshape cities, with huge implications for governments, citizens and corporations.



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## Questions

How could we rethink urban planning to improve public health?

How vulnerable is your city to climate disruption?

Will location still matter in a world of remote work and effortless mobility?

Is your office location strategy rightsized for climate disruption and remote work?

How should your talent strategy adapt to remote work and the future of mobility?

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# Innovating communities

## Is there a big future in small cities?

The majority of humanity will live in cities by 2050. But, in what kind of cities?

The conventional urbanization narrative holds that big cities will only get bigger and economic benefits will continue to accrue disproportionately to hotbed regions, such as the San Francisco Bay Area or Shenzhen in China. However, as we highlight in our “**Remapping urbanization**” megatrend, the future of cities is not more of the same.

A counter-narrative to this urbanization story is arising as global megacities and hotbeds begin to experience the limits to growth, and the forces of disruption continue to drive change that creates new opportunities for legacy cities and smaller cities. The result will be a more distributed, inclusive and resilient global cityscape.

## City limits

A suite of factors will challenge the growth projections for the world’s megacities and hotbeds. Climate disruptions, resource scarcity, pollution, infrastructure gaps and real estate valuations can inhibit growth. Given its water scarcity and pollution, can Beijing add 6.5 million people to reach the population that the United Nations (UN) predicts for it – **27.7 million in 2030\***? Can the San Francisco Bay Area add **1.6 million people by 2040<sup>†</sup>**, as projected, if the median regional home price is already US\$785,000? All-in costs for office space already exceed \$250 per square foot in Hong Kong and \$200 per square foot in London.

This situation has created an outflow of mainly young people seeking lower barriers to entry, lower costs of living and cheaper access to entrepreneurial resources. In India, for example, a growing number of start-up entrepreneurs are leaving or avoiding hotbeds, such as Bangalore, in favor of smaller cities where resources and talent are more accessible.

At the same time, in markets such as the US, the high cost of hotbed areas contributes to growing **income inequality** (see Renewed social contracts) because many current residents can no longer afford to live and work in these areas. People outside the hotbeds can’t afford to move to those regions to pursue the jobs being created in them.

\* [http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the\\_worlds\\_cities\\_in\\_2016\\_data\\_booklet.pdf](http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf)

† <http://2040.planbayarea.org/forecasting-the-future>

## Disruption and city reinvention

The **primary forces** of disruption create new opportunities for second-tier and smaller cities beyond the megacities and hotbeds. For legacy cities, changing dynamics in the same forces that led to their original florescence and subsequent decline are creating new opportunities for revival.

Technologies, such as additive manufacturing (3-D printing), AR and VR, IoT, and AI, that democratize and decentralize the tools of innovation, collaboration and production, open new pathways to developing special knowledge and participating in the global economy from anywhere. If workers can't come to the jobs, the jobs can come to them. The growing number of start-ups embracing officeless organizations in the name of efficiency, both in terms of talent and the cost of office space, illustrate this opportunity. For example, the 130 employees of

the software company Rainforest QA can be found in 25 US states and 13 countries, not in a central office.

Demographic change gives energy to city re-invention as preferences among the young and the old align in cities. Millennials and the growing cohort of seniors prioritize city livability, affordability and mobility. There is an opportunity to both attract new talent and retain the people who generate social capital.

Globalization has accelerated the diffusion of ideas as well as the search for them. Communities of practice now span the globe. Disruptive innovation can start anywhere and grow with global teams, whether the members of those teams are in established hotbeds or elsewhere. As a result, companies and investors increasingly look outside of established hotbeds for new opportunities.

## A new look at old cities

Legacy cities, successful in a previous industrial revolution, but since left behind, offer what megacities and hotbeds lack: excess capacity. Their infrastructure was built out to serve larger populations and larger economies. Cleveland's population, for example, peaked at nearly one million in the 1930s, but now stands at around 400,000. Excess capacity in roads, rail, utilities or office space, while burdensome for the cities to maintain, offers the building blocks of growth.

Similarly, cultural, civic, health care and educational institutions frequently outshine what you'd expect in a smaller city. Remaining businesses tend to have strong community engagement and advocacy.

The urban design, architecture and neighborhoods that seemed outmoded when people fled old city cores for the suburbs have become valued again as preferences shift toward urban living and work.

**Cleveland\*** has become one of the top ten destinations for college-educated millennials, having experienced a 76% increase in its population of residents aged between 25 and 35 since 2000.

## Second-tier and smaller cities benefit

Usually anchored by institutions such as universities, hospitals and government, second-tier cities offer some of the dynamism of their larger counterparts at lower cost. In the US, internal migrants are flowing from San Francisco to Sacramento, New York to Philadelphia and Los Angeles to Santa Barbara.

London's population would be in decline if it weren't for international immigration, the future of which is now in question with Brexit. **Londoners<sup>†</sup>** in the 30-to-40-year-old age range are leaving the city for smaller, less expensive cities, such as **Birmingham<sup>‡</sup>** Brighton and Bristol.

In China, the scale of urban migration dwarfs that of any other nation. Top-down government policies – both incentives and disincentives – encourage movement to second-tier and smaller cities as a way to relieve crowding in megacities, such as Shanghai and Beijing, distributing the benefits of growth more evenly. Since **more Chinese college graduates<sup>§</sup>** say that they would prefer to live in a second-tier city, it seems to be working.

## The city as platform for innovation

Self-sustaining local ecosystems of innovation have bloomed in places, such as Israel's Herzliya, Seoul's Innovation Park, Seattle's South Lake Union neighborhood and Finland's Espoo Innovation Garden. These vibrant places are exemplars for communities worldwide. Community innovation is being democratized.

While approaches vary according to the characteristics of each community, underlying them are innovation precepts that would be familiar to any corporate chief innovation officer. They begin with aiming to "be innovative" rather than "do innovation." Instead of conducting one-off initiatives, communities transform themselves to acquire a set of innovation attributes that will yield sustainable, long-term success.

\* [https://www.clevelandfoundation.org/news\\_itemhttps://www.clevelandfoundation.org/news\\_items/millennial-residents/s/millennial-residents/](https://www.clevelandfoundation.org/news_itemhttps://www.clevelandfoundation.org/news_items/millennial-residents/s/millennial-residents/)

† <https://londonist.com/2016/04/london-migration>

‡ <http://www.bbc.com/news/uk-england-37385265>

§ [http://www.chinadaily.com.cn/china/2017-07/26/content\\_30248921.htm](http://www.chinadaily.com.cn/china/2017-07/26/content_30248921.htm)

They shift culture to embrace risk-taking, pursue new forms of collaboration within municipal government and among community participants (governments, corporates, nonprofits, etc.), and cultivate an entrepreneurial mindset. The ability to establish and orchestrate cross-functional and cross-regional communities of practice is particularly important.

The city is becoming a platform for innovation, not just in technology but also in public space, infrastructure and financing. Emphasizing co-creation and new forms of public-private collaboration, city development becomes less linear and more about enabling constituents to find the upsides of disruption together.

Despite challenges of history and size, legacy and smaller cities have some factors working in their favor. Smaller sizes and fewer stakeholders can generate greater agility and social cohesion. Similarly, smaller project sizes and lower day-to-day operational pressures reduce the cost and risk of experimentation. It's also easier for the citizens of smaller communities to see the benefits of innovative initiatives. Small communities become the test beds for city innovation.

## **Business creates both value for money and shared value**

Business has an important role to play in catalyzing city transformations. A company that is a large employer, taxpayer and consumer of city services can convene key players and facilitate consensus among different resources, experience and global networks to the table.

The citizens of legacy and smaller cities are employees, customers, suppliers and shareholders. Helping them seize the upsides of disruption unlocks not just value for money, but also **shared value** (see Renewed social contracts).

## **Governments address risks and seize the upsides**

For governments at all levels, the concentration of people, wealth and economic activity in megacities brings increased risks, whether resource and climate-related, geopolitical or associated with social equity.

Aligning policies to the forces driving toward a more diverse and decentralized cityscape helps to ameliorate these risks while positioning economies to benefit from the upsides of disruption.



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## Questions

What is the upside for businesses in catalyzing legacy and small city transformations?

Is the high cost of business in hotbed cities worth it?

As digital democratizes innovation, in which community should you look for the next great business idea?

What happens if talent doesn't want to be where you are?

Is job mobility rather than labor mobility the answer to income inequality?

Is a city a place for innovation or a platform for innovation?

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# Health reimaged

## With growing health needs, is digital the best medicine?

There is much to gain from disrupting health care. **Aging** (see Engaged aging) populations and increasingly sedentary lifestyles have put costs on an unsustainable trajectory. Advances that improve health outcomes and care delivery will generate tremendous benefits, not just for patients, but also for governments and businesses.

This is the promise of **health reimaged**\* – the move to an entirely different health paradigm that is predictive, personalized, proactive and participatory. The ubiquity of data and analytics means every company is now a tech company. In the future, companies from every sector will develop products, and increasingly, algorithms to improve individuals' health. Mobile and other empowering technologies are helping drive this shift, transforming patients into **super consumers** who demand greater control of their health through new products and services.

The next generation of disruptive technologies will take this further, allowing the fusion of the biological, digital and physical worlds. AI promises to transform everything, from drug R&D to clinical support. Robots have the potential to provide inexpensive, personalized home care at scale, while AVs will enable seniors to maintain active and independent lifestyles. DNA sequencing and

gene editing could revolutionize drug development and provide new therapies for many grievous diseases. Blockchain could safeguard the integrity of supply chains and clinical trials.

To realize their full potential, these technologies will need to work seamlessly with each other to harness data located outside the traditional health ecosystem. This need is driving the next phase of the journey: the emergence of **health platforms**<sup>†</sup> that connect various stakeholders – patients, providers, payers, policymakers and manufacturers – enabling them to combine capabilities and share personalized health data safely and in real time. Initially, these platforms focus on specific diseases; over time, individual platforms will be connected to provide insights across multiple disease areas simultaneously.

As health is reimaged, power will continue to shift to consumers and new entrants. To respond to this shift, companies must adopt agile, data-centric business models to create innovations that meet the demands of consumers and other constituents.

\* <http://www.ey.com/gl/en/issues/business-environment/ey-megatrends-health-reimagined>

† [http://www.ey.com/Publication/vwLUAssets/ey-when-the-human-body-is-the-biggest-data-platform-who-will-capture-value/\\$FILE/ey-when-the-human-body-is-the-biggest-data-platform-who-will-capture-value.pdf](http://www.ey.com/Publication/vwLUAssets/ey-when-the-human-body-is-the-biggest-data-platform-who-will-capture-value/$FILE/ey-when-the-human-body-is-the-biggest-data-platform-who-will-capture-value.pdf)



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## Questions

How will human augmentation technologies improve care, expand access and lower costs?

How will new technologies and approaches enable us to remain active and independent as we age?

How will the move to health reimaged play out in emerging markets – and what could industrialized nations learn from them?

How will the move to health care platforms affect your business model?

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## Resources

# Food by design

## Can innovation align delicious with sustainable, affordable and healthy?

The US\$5 trillion global food industry is experiencing the cross-currents of disruption.

Food companies deliver mass products from far-flung supply chains even as consumers demand local, transparently sourced, personalized foods. Agriculture generates 24% of greenhouse gases\*, consumes 70% of fresh water<sup>†</sup> and occupies nearly 40%<sup>‡</sup> of the global landmass. Climate change and population

growth render this kind of resource consumption increasingly untenable. The diffusion of the modern western diet contributes to a variety of global health problems, such as heart disease, cancer and diabetes. More people now suffer from obesity<sup>§</sup> than from malnutrition.

Innovations at the intersections of food, biotech, wellness and digital are emerging from these cross-currents to design new ways to eat.

## Protein by design

Animals are an inefficient means of producing protein at a mass scale. It takes 100 calories of feed inputs to produce three calories of beef<sup>¶</sup> for human consumption. Beef production requires 20 times\*\* more land and emits 20 times more greenhouse gas emissions per unit of edible protein than plant-based protein sources. If cows were a country, they would be the third-largest<sup>††</sup> greenhouse-gas-emitting nation.

Animals are also alive. The industrial systems and supply chains required to deliver animal products at scale introduce livestock diseases and human pathogens, and create animal "suffering on a truly massive scale," in the words of Yuval Noah Harari in his book *Sapiens*.

Yet, people want meat. As the global population grows by 2.5 billion through 2050 and income growth swells the global middle class, the UN's Food and Agriculture Organization<sup>‡‡</sup> expects meat production to double. The global livestock herd could reach 40 billion by this date, with enormous sustainability impacts.

Food innovation approaches that cater to the consumer preference for meat rather than try to change it are disrupting this narrative. One approach focuses on creating vegetable-based meat and dairy substitutes that have the taste and experience of the real thing, but without the caloric inefficiencies and sustainability impacts.

\* [https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc\\_wg3\\_ar5\\_chapter1.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter1.pdf)

† <http://www.oecd.org/agriculture/water-use-in-agriculture.htm>

‡ <https://data.worldbank.org/indicator/AG.LND.AGRI.ZS>

§ <http://www.who.int/mediacentre/factsheets/fs311/en/>

¶ <http://iopscience.iop.org/article/10.1088/1748-9326/11/10/105002/pdf>

\*\* <http://www.wri.org/blog/2016/04/sustainable-diets-what-you-need-know-12-charts>

†† <http://www.fao.org/news/story/en/item/197623/icode/>

‡‡ <http://www.fao.org/ag/againfo/themes/en/meat/home.html>



Pea proteins, wheat and potatoes are being turned into hamburgers. Oats become yogurt. Mung beans become eggs.

The other approach draws on biotechnology to grow meat, dairy proteins and animal products, such as leather, in the lab. This cellular agriculture, dubbed clean meat, grows animal cells in a medium of amino acids, sugars, minerals and water, much more efficiently than an animal can, achieving one calorie of output for just three calories of input. Growing animal products in the controlled lab environment avoids the pollution, greenhouse gases, water consumption and sanitary problems of conventional production. Meat can also be grown much closer to demand, cutting short an extended global supply chain.

Rather than pursuing niche vegan markets, the companies developing meat substitutes and clean meat aim squarely for the mainstream market where their products must compete on taste, cost and convenience, not on consumer values. Success depends on achieving scale to lower costs and continuing innovation in the product experience. As with renewable energy or EVs, market adoption will begin with consumers willing to pay a premium or have a suboptimal experience, then move to the mainstream as cost and performance improve. At the same time, we can expect the cost of conventional animal products to rise as the increasing negative externalities of their production become integrated into prices. Large meat suppliers appear ready to help these innovations scale. The venture arm of Tyson Foods, which is exploring and investing in non-meat protein alternatives, has invested in the plant-based

protein company Beyond Meat. Both Tyson Foods and Cargill have invested in the clean meat start-up Memphis Meats. These products become part of an overall protein portfolio that can scale with demand. They also come without the sustainability and health tensions that characterize conventional meat supply chains.

While the large food companies are invested in processing and distributing meat, they don't own herds or farms and can adjust nimbly to consumers' shifting preferences. The companies raising livestock are most threatened by the emergence of protein by design.

China, one of the main drivers of global meat demand, also recently gave a boost to the scaling clean meat industry. It signed a US\$300 million trade agreement with Israel for lab-grown meat from the Israeli start-ups SuperMeat, Future Meat Technologies and Meat the Future. Lab-grown meat addresses the Chinese imperatives of lowering greenhouse gas emissions, improving food safety and increasing food security.

## Smart vertical farming: produce by design

Consumer preferences, urbanization and the continuing decentralizing force of technology open the door to bringing farming to cities at significant scale. Digitally enabled vertical farms decouple production from climate, enabling food to be grown close to the source of demand – increasingly, cities – without pesticides or herbicides, meeting consumer preferences for products that are fresh, local, organic and transparent.

While it is difficult to compete against the cost structure of traditional farming, vertical agriculture has a number of countering advantages:

- ▶ Production close to demand, cutting out the transportation expense and many middlemen in the traditional supply chain
- ▶ Consistent supply at predictable prices for local retailers, regardless of global weather
- ▶ Plants custom-grown to meet local tastes
- ▶ Consumers willing to pay a premium for super-fresh, traceable and sustainable food
- ▶ More yield per square meter, with waste and significant carbon and water savings
- ▶ Potential to address food deserts in low-income areas
- ▶ Ability to tie production to individual consumer demand through digital applications and supermarket data

The US start-up Plenty recently secured US\$200 million to build 300 vertical farms on the edge of urban areas to meet the growing demand for wholesome, traceable food in the wake of national food safety scandals.

Plantagon, a Swedish company, places the vertical farm in the context of the “symbiotic” smart city. It is building a “plantscaper” that combines office space with a robotic hydroponic vertical farm capable of producing 550 tons of vegetables per year. The building will utilize waste heat and carbon dioxide from neighboring businesses, and could also recycle water. The vertical farm becomes a key contributor to a city’s **circular economy**\* and overall sustainability while benefiting economically.

\* <https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept>

## Human biome: diet by design

Biotech and food converge in the growing understanding of the role that the human gut biome – the unique set of trillions of micro-organisms present in every person's digestive track – plays in human health. While we used to know only what foods were generically good for people through the analysis of the biome, it is now possible to determine which foods are optimal for **you as an individual**.

DayTwo, an Israeli company, has commercialized a diagnostic that analyzes the DNA of your gut biome and uses an algorithm based on extensive clinical research to predict your glycemic (blood sugar) response to different foods, which varies significantly among individuals. Glycemic spikes are associated with disorders, such as obesity and diabetes. DayTwo currently offers individual wellness diet recommendations, and is collaborating with Johnson & Johnson to develop nutrition-based health solutions and biome-based treatments for metabolic disorders.

This development flips our perspective from viewing food as a source of illness to food as a source of wellness, with new opportunities to reduce health costs, improve outcomes and maintain wellness.

Taken together, these trends mean that our eating will be personalized, local and increasingly sustainable for human health and the planet. We will feed more with less.



## Questions

How long can we avoid paying the true cost of food?

Is it more important to fulfill consumer values or appetites to expand markets for sustainable food?

How will vertical urban agriculture change the social and sustainability dynamics of cities?

If personalized diets become the key to wellness, what industry is the food business in?

How can the global food industry serve one diet at a time?

How will food innovation redefine farm work?

# Molecular economy

## Nature is clean, efficient and distributed – why is manufacturing not so?

There is a revolution in the making. In 2017, IBM Research discovered a way to store one bit of digital information in a **single atom**<sup>\*</sup>, a density that would allow the storage of Apple's entire 26-million-song music catalog on a device the size of a coin. Researchers at the UK's Durham University used light-activated **motorized molecules**<sup>†</sup> to drill into cancer cells, destroying them in 60 seconds; animal testing will follow. And, Dubai wants to

**3-D-print 25% of its new buildings**<sup>‡</sup> by 2030. In this revolution, physical, digital and biologic systems converge to create clean, efficient and distributed production processes.

## Nanotechnology enters its disruptive phase

Technology adoption and diffusion tend to follow a recognizable trajectory. After a period of research, technologies are first harnessed for productivity improvements and incremental innovation. The next phase is one of disruptive innovation. From business model to value chain reinvention, new ways of doing things emerge that overturn the existing order.

Nanotechnology, comprised of the various disciplines that incorporate understanding and manipulating matter at the extremely small 1-100 nanometer (nm) length range, is on a similar trajectory. Working at this scale is not new. Products such as golf balls, shampoos, weatherproof garments, coatings and polymers

have long contained nanoscale structures to increase their quality and functionality. The world's first **5nm**<sup>§</sup> chip was introduced in 2017. Clustered regularly interspaced short palindromic repeat (CRISPR) gene editing technology reflects advances in miniaturization in biology.

Our understanding of what happens at the molecular level and our ability to manipulate what we want to happen is increasing. Integrated research across disciplines spanning materials, biology, computing, electronics, mathematics, physics and chemistry signals that nanotechnology is just entering its disruptive phase. What we make and how we make it will change, challenging existing manufacturing paradigms.

\* <https://www.cnet.com/news/ibm-storage-atom-breakthrough-quantum-computing-research/>

† <http://www.telegraph.co.uk/science/2017/08/30/nanomachines-drill-cancer-cells-killing-just-60-seconds-developed/>

‡ <http://www.constructionweekonline.com/article-38750-dubai-25-buildings-to-be-3d-printed-by-2030/>

§ <https://www-03.ibm.com/press/us/en/pressrelease/52531.wss>

## Manufacturing looks to nature for inspiration

Bits are the building blocks of digital computing. Atoms are the building blocks of physical matter. They are both assembled by code. Binary code provides executable instructions for computers. DNA carries coded instructions that determine the structure and function of living organisms. In principle, biological principles and information are translatable into computing environments and vice versa.

Why is this important?  
Human beings have been making things for thousands of years.

The desire to create useful and beautiful things is inseparable from the human experience. But, nature has been making things for billions of years, developing **clean, efficient and distributed** methods through the evolutionary process. The disruptive phase of nanotechnology and its applications will mimic the processes of nature while exploiting new and powerful capabilities and tools. And, we will make useful and beautiful things by leveraging these knowledge sets.

## The search for clean and more functional materials

Nature is clean and resource-efficient. Older manufacturing techniques (typically physics-based and reliant on high-temperature processing technologies) can be dirty and wasteful. By exploiting the unique optical, electrical, catalytic, magnetic and chemical properties of matter that take place at the nanoscale, humans can build cleaner materials and production processes.

Abundant resources, such as carbon, are being engineered at the nanoscale to create new materials, such as **graphene\***, which can be substituted for more costly **metals†**. Super-light **aircraft‡** made with graphene could reduce fuel costs.

**Ultrathin materials§**, some of which can change or evolve in response to forces, such as heat, light or electricity, could lengthen battery life, make solar cells more efficient and desalinate water. **Self-healing materials¶** could prolong the useful life of products, diverting them from the waste stream. With concrete production contributing 10% of global carbon dioxide emissions, lab scientists are focused on manipulating nanoscale particles in **cement\*\*** to make a more durable and less resource-intensive product.

\* <https://www.businesswire.com/news/home/20170202005599/en/Graphene-2-D-Materials-Global-Opportunity-Market-Forecast>

† <https://www.chalmers.se/en/departments/tme/news/Pages/Graphene-and-other-carbon-nanomaterials-can-replace-scarce-metals.aspx>

‡ <http://www.telegraph.co.uk/business/2017/03/28/planes-will-made-wonder-material-graphene-10-years/>

§ <https://www.acs.org/content/acs/en/pressroom/presspac/2017/acs-presspac-may-31-2017/searching-beyond-graphene-for-new-wonder-materials.html>

¶ <https://www.prnewswire.com/news-releases/emerging-opportunities-for-self-healing-materials-300547919.html>

\*\* <http://news.rice.edu/2016/12/07/decoding-cements-shape-promises-greener-concrete-2/>

## Efficient production and the molecular manufacturing dream

Nature is efficient at making big things from small things. Instructed by genetic code, atoms and molecules assemble themselves to form large, complex living organisms.

After years of sophisticated equipment development and investments in process improvement, advanced manufacturing has become highly efficient. The adoption of robotics, machine learning algorithms and **virtual factory twins**\* will optimize factories in new ways, making them even more productive.

But, traditional manufacturing methods still rely largely on assembling larger things from smaller things, resulting in long supply chains. Part of this challenge is being solved with the help of 3-D printing. Rapid prototyping is minimizing the R&D cycle. Additive manufacturing is becoming more precise and is capable of working with new materials, including metals. The networking of 3-D printers is allowing useful data to flow back to manufacturers, enabling continuous learning at large scale.

With the help of robotics, manufacturers can now use additive manufacturing to create large-scale objects and final production components in the automotive, aerospace and construction industries.

But, what if we could manipulate atoms and molecules to construct larger, more complex objects to atomic precision? This is the dream of **molecular manufacturing**<sup>†</sup>.

Theoretically, bottom-up production could be fast, efficient, cheap and defectless. At a high level, the concept of molecular manufacturing envisions molecules self-organizing to form larger structures under specific instructions or environmental cues (self-assembly), or through the use of nanoscale tools that hold, position and generate molecules (positional assembly).

Researchers are using **self-assembly**<sup>‡</sup> to create novel materials and exploring the use of programmable nano-robots to perform **molecular manipulation**<sup>§</sup> and **synthesis**<sup>¶</sup>.

## Distributed manufacturing – short supply chains and consumers becoming producers

Natural systems are distributed and self-organizing. From cells to ants to flocks of birds, productive collective behavior at a global level emerges from the collaboration of agents at the local level. Similarly, technological advances are enabling a distributed manufacturing paradigm, benefiting existing manufacturers even as they

bring forth a global maker movement. Digital technologies plus 3-D printing enable distributed but coordinated manufacturing, with benefits in the form of shorter supply chains, lower shipping costs, less unsold inventory, local product tailoring and new business models, such as manufacturing as a service.

\* <https://www.ge.com/reports/twinsies-digital-twin-wins-accolades-tames-factory-operations/>

† <http://www.imm.org/>

‡ <https://www.sciencedaily.com/releases/2016/08/160808120712.htm>

§ <https://www.sciencedaily.com/releases/2017/09/170914152413.htm>

¶ <https://www.sciencedaily.com/releases/2017/09/170920131744.htm>

Today's massive distribution networks that enable service calls and spare parts delivery will slowly disappear. Production will take place closer to where the need is, including battlefields or disaster areas. Robotics, 3-D printing and software-directed assembly of large parts could even enable manufacturing in space.

Community-based production is rising in parallel with the decentralization of large manufacturing. Consumers are becoming producers. MIT's **Neil Gershenfeld** contends that the projected growth in fabrication laboratories (**fab labs**\*) across the world (more than 1,200 today) will lead to exponential growth in their capability to program and fabricate physical forms, creating new sources of manufacturing R&D and entrepreneurial talent.

## The upside of disruption – will nanotechnology become foundational?

The promise of nanotechnology is driving significant investment and focus. The global **nanomedicine market**<sup>†</sup> alone could grow by double digits annually to reach US\$351 billion by 2025. The **global market for graphene**<sup>‡</sup> is on track to reach US\$1 billion by 2025. Meanwhile, governments are funding technology road maps and multidisciplinary research on commercializing and scaling nanotechnologies, as well as understanding and mitigating the risks. Led by China and the US, more than **60 countries**<sup>§</sup> now have such programs.

Scientific uncertainty remains, particularly around molecular manufacturing and the ability to scale up some of the most promising research. At the same time, we are likely entering a multiyear period of nanotechnology-driven disruption, with a variety of new specialty applications coming to market. Even if it takes several decades, the long-term view suggests that a new molecular economy will emerge – one with an impact as great as any of humanity's prior technology-fueled revolutions.

\* <http://iwer.mit.edu/wp-content/uploads/2017/11/Designing-Reality.introduction.pdf>

† <https://www.grandviewresearch.com/press-release/global-nanomedicine-market>

‡ <https://www.prnewswire.com/news-releases/global-graphene-market-2017---a-1-billion-market-by-2025-300561732.html>

§ <https://www.materialstoday.com/nanomaterials/comment/the-nanotechnology-race-between-china-and-usa/>





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## Questions

When we can build everything atom by atom, will scarcity become a thing of the past?

When smarter factories give you operational visibility, what new opportunities will you see?

When parts can be made anywhere, how will you rethink your supply chain?

How are you leveraging advanced materials to improve product performance?

How are you digitizing your products to extend your connections to customers?

How can new business models such as manufacturing-as-a-service improve your cost structure and drive innovation?

# **Future working worlds**



## Rebalanced global system

### In a hyper-connected, multipolar world, how and where will power congregate?

We are in the early stages of moving to an emerging multipolar global order, governed by different rules, norms, institutions, networks and centers of power.

The primary forces of disruption are driving this transformation. Over several decades, globalization has spread to formerly closed economies. India began to liberalize in 1991 and became a World Trade Organization (WTO) member in 1995. China started its “reform and opening up” policy in the late 1970s and gained accession to the WTO in 2001. Russia joined in 2012. This market liberalization has fueled growth, raised living standards and created new economic powerhouses whose rise will reshape the global system in years ahead. The current upswing in **populism**, whether sustained or not, is unlikely to reverse this trend.

Meanwhile, technology has increased connectivity and created new growth opportunities, such as trade in services and intangibles. We now take global telecommunications and coordinated supply chains for granted, but the impact of these connections has yet to fully play out. In the coming years, the interplay between the next waves of technology (**human augmentation**) and demographics (**aging**) will create new pressures and rebalance economic power across different regions.

First among the new economic powers is China, which is taking a lead role in creating institutions and initiatives that could shape the rules of trade and shift the global balance of power. While the next global system will emerge from the collective impact of multiple trends and actors, this initial analysis focuses largely on the rise of China. We will explore other trends reshaping the global system in the months ahead.

### China’s ambitions are creating new institutions and initiatives

For China, the pivotal moment came in 1978 when former leader Deng Xiaoping steered the country toward “reform and opening up.” When Xi Jinping came to power in 2012, the country had experienced hyper growth, but numerous Chinese companies and local governments

were also over-leveraged. The Communist Party of China (CPC) concluded that for the country to fulfill its **China Dream**\* of national rejuvenation, the country must curb financial risk and embrace a developmental path of innovation and reform.

\* <http://www.nytimes.com/2013/06/05/opinion/global/xi-jinpings-chinese-dream.html>

The crown jewel of China's international strategy is the Belt and Road Initiative (BRI), heralded\* as the modern-day Silk Road. BRI entails building a vast network of land and sea links across more than 60 countries. The plan recognizes the massive infrastructure gap in developing economies as an underlying impediment to economic progress. On balance, China focuses on trade and economic development while being mostly agnostic about the local politics of its trading partners.

China has led in founding a new set of international institutions, such as the Asia Infrastructure Investment Bank (AIIB) and the New Development Bank (NDB), to finance these infrastructure projects in developing economies. China believes that these new institutions can improve the speed of approval and execution of development projects. While it has been working with the World Bank and the International Monetary Fund (IMF), the structure and voting rights of these western legacy institutions have remained relatively inflexible despite changing power dynamics. New institutions, such as the AIIB and NDB, could help address this mismatch.

Domestically, China is relentlessly focused on innovation, rapidly acquiring western technologies and promoting indigenous innovation to narrow technology gaps. Nowhere is this more evident than in the areas of AI, quantum computing and EVs. With the help of the country's internet giants, China is already using AI† on image scans at hospitals for cancer detection. Public buses in Shenzhen have already been fully converted‡ into EVs. China now accounts for nearly half of all plug-in vehicle sales worldwide.

China is also making efforts to increase its soft power. Through nonprofits, such as the China Culture Centers and Confucius Institutes, China is promoting its language and culture around the world. In the commercial realm, private companies, such as Wanda, have heeded the Party's call to strengthen the country's soft power§ by acquiring western media assets in the areas of films, television and movie theaters.

\* [http://news.xinhuanet.com/english/2017-05/14/c\\_136282982.htm](http://news.xinhuanet.com/english/2017-05/14/c_136282982.htm)

† <https://www.nytimes.com/2018/01/31/technology/amazon-china-health-care-ai.html>

‡ <https://www.engadget.com/2017/12/29/china-shenzhen-public-electric-buses/>

§ [http://www.chinadaily.com.cn/china/2017-10/21/content\\_33517509.htm](http://www.chinadaily.com.cn/china/2017-10/21/content_33517509.htm)

## These institutions and initiatives will shape the next global system

As China catches up to the West and moves up the value chain of production, other developing economies will likely take the low- to mid-end work that no longer fits the Chinese economic model. With China leading the building of the needed infrastructure to enable commerce, developing countries in Central Asia and Africa might more readily attract foreign businesses and investments. This might drive a new economic boom in these regions, similar to the growth seen in many East Asian economies in decades past. Global trade flow will become more complex and integrated as these new sources of production are activated, creating opportunities for companies to rebalance their procurement and manufacturing strategies.

More importantly, China's emergence as a leading force in global trade means that countries are likely to increasingly work with its institutions, creating a workable alternative to the West's order. It is difficult to foresee how other countries will interact with these parallel systems. One possibility is that the Western system, by virtue of its age and rigidity, fails to keep up with modern requirements; another is that China fails to open its home markets and win converts to its philosophy so that trading countries prefer the existing institutions. Or, these developing countries may even consider forming their own alternatives.

Internal and external challenges will determine the extent to which China achieves its vision. Externally, the US\* and Europe† are placing greater scrutiny‡ on Chinese overseas acquisitions. Meanwhile, India is skeptical about the BRI, but has not yet offered an alternative of its own. Internally, China must deal with corruption, a high-flying stock and real estate market, non-competitive state-owned enterprises, aging demographics, pollution, excessive local government debt, and income inequality.

\* <https://www.nytimes.com/2017/11/08/us/politics/china-foreign-investments.html>

† <https://www.ft.com/content/04fa752c-7dda-11e7-ab01-a13271d1ee9c>

‡ <https://www.nytimes.com/2018/03/06/business/qualcomm-broadcom-cfius.html>

## What will the next global system look like?

While there are still many unknowns, the next global system will likely be characterized by five attributes:

1. **Multiple poles:** The next global system will feature neither the polarized ideological conflict of the Cold War nor the extreme dominance of one power across economic, military and cultural dimensions. Instead, it will be multipolar, with different countries influential across particular dimensions.
2. **New institutions for new realities:** The global order will be shaped by new initiatives and institutions, such as BRI and AIIB. While building spheres of influence for their sponsoring countries, such efforts will also better reflect changing power dynamics, thereby reducing the potential for conflict.
3. **Connectivity:** The ascendant powers depend greatly on trade. The new institutions they are founding will champion trade, even as initiatives, such as BRI, boost physical networks that lead to greater movement of capital and people.
4. **Regional rebalance:** We will likely see a relative shift in focus across regions. For instance, BRI could supercharge the growth of developing countries in Central Asia and Africa, much as the US-led global system allowed Japan and several Southeast Asian countries to become economic powerhouses.
5. **Diverse norms:** The global order will be marked by a uniquely complex mix of connectivity, multipolarity and divergent norms. China has its own rules for organizing the Internet. Russia has different norms for free speech. For companies, navigating this reality will be a complex challenge.



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## Questions

Will connectivity democratize prosperity?

How will your strategies, policies, talent and networks adapt to a multipolar world?

Is your company prepared for a world in which innovation could come from anywhere?

How is your global strategy looking beyond China and India to focus on fast-growing economies in Africa and elsewhere?

How should the composition of your board and C-suite change in a multipolar world?

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## Renewed social contracts

### Will we renew our social contracts through reform – or revolution?

We may not give it much thought, but we all live within a social contract. Every society has one. A social contract (also known as a social compact) is simply the collection of implicit or explicit agreements that enables citizens to live together in a civil society. It encompasses everything, from the rule of law to regulation to a society's approach to health care.

These contracts are neither uniform nor static – they vary across societies and over time. Regardless of such differences, though, all social contracts attempt to provide stability by seeking to balance the needs of citizens and governments, workers and employers, and the individual and the collective.

The societies of the future are likely to have very different social contracts from the ones we see today. The reason is that disruption has been straining long-standing social contracts, and the next waves of technology, globalization and demographics promise to take them past the breaking point. What follows after this will likely be quite different from what we have seen so far – simply because new economic realities will demand new solutions and traditional approaches may no longer be viable.

### Rising inequality

The pressures on social contracts have been building for some time now. Economic inequality has steadily become more extreme across most of the world, driven, in large part, by the primary forces of globalization and technology. Developments, such as refugee crises and human migration, are adding to the strain.

The next waves of disruption promise to drive these conflicts to a breaking point. The future of work and human augmentation could produce a massive displacement of work and workers. Without corrective measures, these trends will compound economic inequality and bring social contracts to the point of collapse.

The future of work is directly undermining key elements of today's social contracts. The gig economy, in particular, reduces the efficacy of aspects of social contracts that are often tied to the employer-employee relationship (e.g., retirement savings, workplace protections, collective bargaining, overtime pay and health care). Meanwhile, technologies, such as social media, are polarizing social discourse. Online "echo chambers" make it increasingly difficult to find middle ground and enact policy fixes that could reform social contracts.



These trends will have tremendous ramifications for social contracts in the developing world. Workers in emerging markets, who have so far benefited from the globalization of supply chains and workforces, could find their jobs replaced by automation. Demographics could make this issue even more volatile; except China, most of the developing world skews overwhelmingly young. With large numbers of unemployed youth, developing countries' social contracts would face even greater strain than those in the West.

## **Collective action challenges**

A second trend exacerbates these pressures: the ticking time bomb of collective action challenges. Across the globe, issues, such as climate change, chronic diseases and excessive debt, are becoming increasingly urgent and expensive.

The common thread through these issues is that they require us to act collectively and make short-term sacrifices for our long-term benefit. However, a number of structural and behavioral barriers – including election cycles, quarterly earnings expectations and universal human biases that overweight the short-term – prevent individuals, companies and policymakers from focusing on our collective, long-term interests.

## **What will the new social contracts look like?**

Where will these rising pressures take us? What will the social contracts of the future look like? As with today's compacts, we expect different societies to arrive at different solutions for the challenges created by disruption.

Some societies may proactively implement reforms to make social contracts more sustainable. In others, revolutions – at the ballot box or in the streets – may generate change.

## Four principles

Regardless of how they arise and what mix of solutions they enact, the social contracts of the future will follow four principles:

1. **Inclusive:** To combat rising economic inequality, future social contracts will be more inclusive. For corporations, this means that companies will be accountable not just to shareholders, but also to a broader set of stakeholders. Digital disruption has already made information transparent and empowered individuals, trends that will continue with the rise of blockchain and adaptive regulation.
2. **Long-term:** Similarly, tomorrow's social contracts will be more aligned around long-term interests and behavior. Today, all of society's stakeholders, including individuals, corporations and governments, are excessively focused on short-term behaviors and outcomes. Incentives, including those based on behavioral economics, will help change this to tackle major collective action challenges.
3. **Market-based:** For social contract reforms to be sustainable, it's critical that they be rooted in the private sector. Social contracts will realign interests so that companies act more inclusively and with a long-term focus, not because of corporate social responsibility initiatives or for public relations benefits, but because doing so is good for the bottom line.
4. **Policy-driven:** Governments will play a key role in realigning the interests of private sector actors with the long-term inclusive needs of society. Specifically, new policy measures will bridge gaps and address market failures. Many of these policies will incorporate behavioral economics.

## Key issues

In addition to following the four principles, the next social contract must address issues such as these:

- ▶ **Democracy:** For the last century or so, democracy has been a key pillar of social contracts across much of the world. Today, democracy is under attack, a victim of the same forces that are undermining social contracts. The next waves of digital disruption will further this trend, as might the rise of a **new global system** influenced by different values and norms.
- ▶ **Inequality:** Sustainable social contracts must address economic inequality. Traditionally, policy solutions have included a combination of progressive taxation and safety net programs, such as pensions, unemployment insurance and health care coverage. Such mechanisms will continue to be important. But, the extent of labor disruption that lies ahead might also require new approaches, including, perhaps, some form of universal basic income.
- ▶ **Learning:** Education is a central pillar of social contracts. But, today's educational systems are fundamentally misaligned with the future of work. We, therefore, expect to see a long-overdue disruption of education. The social contracts of the future will have a new approach to learning: one that is lifelong, technology-enabled and entered on developing skills instead of imparting knowledge.
- ▶ **Regulation:** Regulation is a key part of any social contract. Appropriate regulation is one of the most important mechanisms for balancing the interests of workers, consumers and small businesses against those of more powerful institutions. Disruption is already straining traditional regulatory paradigms and the problem is only going to get worse. The social contracts of the future will, therefore, have to fundamentally rethink regulation. (For more, see "**Adaptive regulation**".)
- ▶ **Metrics:** The move to the next social contract will need measures of value that are long-term and inclusive. The measures used by companies to track and report their value creation will need to become long-term and accountable to a broader set of stakeholders. Different frameworks and legal structures (e.g., the benefit corporation, the low-profit limited liability company (L3C) and **triple bottom line**\*) will be important for enabling this shift. Similarly, the measures that governments use to track economic activity, such as GDP and unemployment rate, will need to be redefined in an era of disruption.

\* <https://www.economist.com/node/14301663>



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## Questions

How will society's constituents – citizens, governments and businesses – make social contracts more inclusive and long-term?

How will societies address income inequality in an era of workplace automation?

How will societies replace eroding worker protections and social safety nets in the future of work?

What responsibility should businesses have for tackling income inequality?

At a time when companies are increasingly vocal on political issues affecting their stakeholders, how are you responding?

How are you measuring and reporting value to align with the long-term interests of all your stakeholders?

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## Superfluid markets

### Is frictionless commerce an opportunity to deploy time and capital in more constructive ways?

Business in the future looks very different. Here's a look ahead to 2030:

Supply meets demand seamlessly across market types. Problems, such as excess capacity and inventory, no longer exist. Companies are hyper-lean, staffed primarily with freelancers who come together for specific tasks, then disband. Every company asset is obtained as a service. Autonomous organizations compete with those still run by people. Intelligent machines help manage and direct the work flow.

Integrity and trust between buyers and sellers is established through code. Organizations compete solely on value creation as efficiency is no longer a differentiator.

In physics, superfluids have the unique property of zero viscosity. They flow without friction. Similarly, a new generation of technologies and innovators is bringing us closer to the age of superfluid markets, where traditional frictions and inefficiencies are greatly reduced or even eliminated.

### From viscous to fluid to superfluid – a short history of markets

Markets exist to bring together buyers and sellers of goods, services, information, labor and other assets of value. Globalization, technological advances and other forces that emerged during the Industrial Age dispersed markets and made them more complex. Companies arose, in part, as structures for efficiently coordinating participation in more intricate, costly and far-flung markets. In each industry, a web of intermediaries also emerged to make transacting easier.

Over time, market frictions have been steadily receding:

**The viscous market age:** Up until the arrival of the Internet, most markets were viscous. It was a world of paper, typewriters and ringing telephones. Executing buyer-seller transactions was an expensive, slow and opaque process. These frictions were largely related to the lack of information on the part of market actors, as well as information asymmetry that tended to benefit sellers at the expense of buyers. The need to navigate market access generated multidisciplinary companies with large workforces.

**The fluid market age:** The arrival of the Internet and digital commerce introduced a level of fluidity not enjoyed in the viscous market age. The Internet democratized access to information, reducing information asymmetry. New virtual markets arose, matching buyers and sellers in a more frictionless way. Entire industries were disrupted. For companies, the digitization of business processes, from hiring to procurement and sales and marketing, greatly reduced the internal coordination costs of participating in markets. As a result, companies began to unbundle, pursuing alternate ways to get work done like outsourcing and co-creating with customers.

**The superfluid market age:** We have now entered the age of superfluid markets. New technologies are converging to eliminate even more inefficiencies and frictions from markets. The price and performance of computing continues to climb an exponential curve. Data storage capacity in the cloud is virtually infinite. The physical world is being sensed, tagged and linked to the Internet. Massive amounts of new data are being generated. AI algorithms are analyzing that data. New market interfaces are arising. Blockchain technology shows promise to establish trust between market participants in a decentralized, encrypted and secure manner.

While we can't predict exactly what the future will look like, superfluidity will have a profound impact on both markets and companies as we know them today. Here are a few of the ways in which markets and companies could change.

## How will superfluidity impact markets?

New markets will form and superfluidity will reinvent existing markets. The collision of real-time communications and the IoT will give rise to "stock exchanges" for all kinds of goods, not just commodities. Everything, from drones to manufacturing equipment, will become available on an as-a-service basis. New markets for raising capital (e.g., initial coin offerings) will emerge. The increasing recognition of personal data as a valuable asset will likely lead to new personal data exchanges.

Excess or idle capacity will fade away. Digital intermediaries have already aggregated idle consumer assets, such as cars and apartments. This sharing economy model will spread to expensive but underutilized capital equipment – from tractors to magnetic resonance imaging (MRI) machines – owned by businesses. The model will also extend to services industries, where individual skill capacities are also under-leveraged.

Markets will become more autonomous. Digitized assets linked to intelligent systems with blockchain as the underlying trust engine could eventually enable fully autonomous markets to flourish. Machines will begin to transact autonomously with other machines as well as directly with people – automatically requesting service, triggering inventory replenishment and bidding for power, among other activities.

Technology leapfrogging will supply “missing markets” in low income, rapid growth economies. Mobile money transfer and payment systems will create new financial markets. The IoT will enable rural electricity markets through the installation of smart solar units managed centrally in off-grid areas and paid for using mobile phones. Blockchain-enabled land registries will enable real estate markets free of corruption and ownership disputes.

## **How will superfluidity change companies?**

With fewer market frictions to manage, companies of the future will be extremely lean. They will be built around teams. These teams will assemble around tasks; employees will no longer be organized by role. Teams will be autonomous, self-driving and supported by intelligent machines.

The percentage of freelance labor will grow as the lifetime employment model fades. Organizations that have no permanent employees may arise. Today, online labor platforms connect companies to individual freelancers to perform specific tasks. Tomorrow, organizations will post challenges that require people collectives.

The platform economy and the “as-a-service” revolution will continue to make it easier and less costly to start up a new business. Entrepreneurs will increasingly be able to leverage a variety of modular, scalable services that give them immediate market access, distribution channels and more.

New technologies will continue to spur new operational efficiencies and increases in productivity. As company activity becomes less and less about managing transactional and other kinds of frictions, the opportunity for a company to compete on efficiency will fade. Instead, a company’s ability to drive innovation that results in new value creation will be the most important determinant of its competitive positioning – and its long-term survival.



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## Questions

How will you compete on value when competing on efficiency is no longer an option?

What new frictions will arise in your business as the old frictions melt away?

Will you make your markets superfluid or will others do it for you?

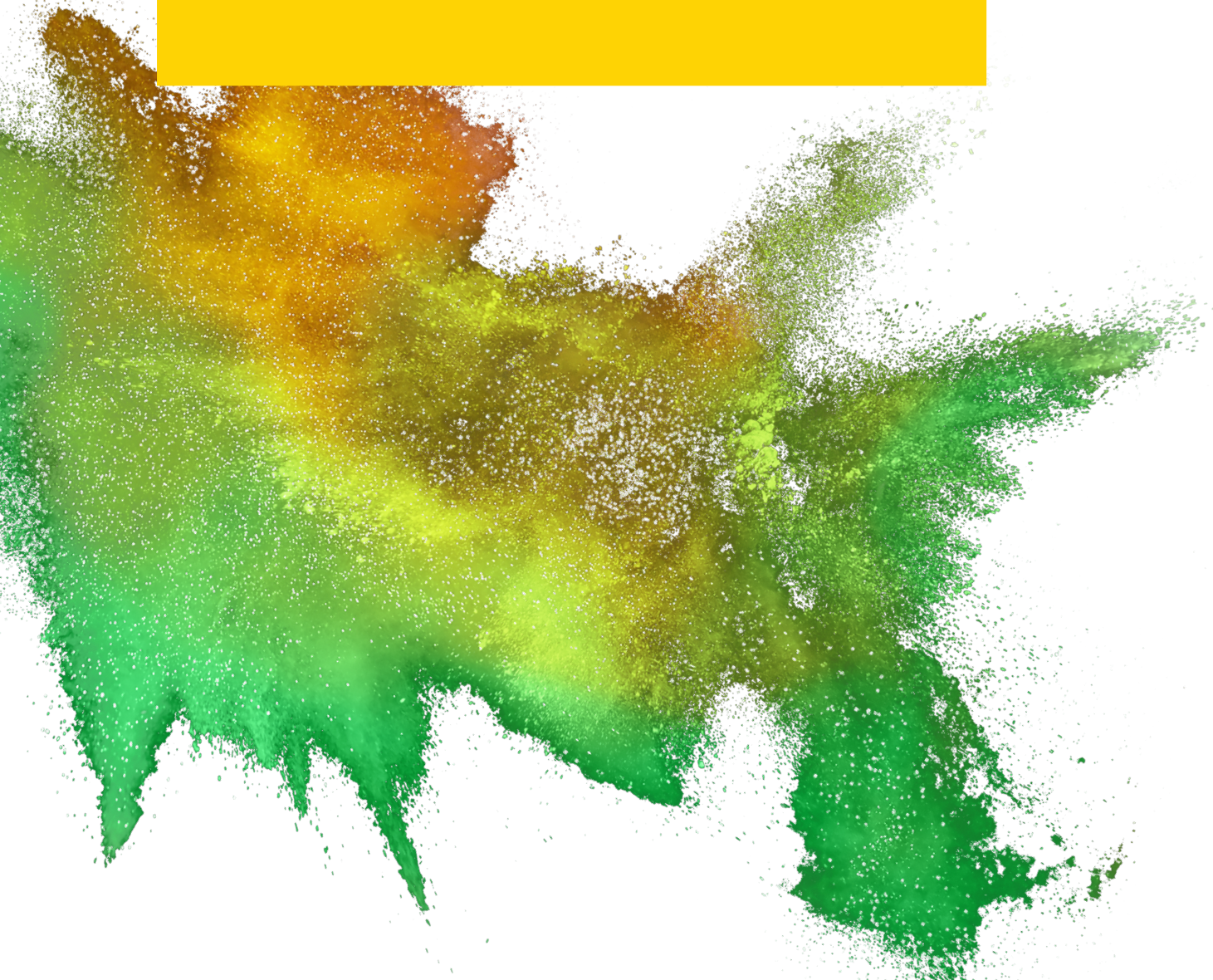
What new technologies and strategies are you deploying to help supply better meet demand?

How are you incorporating new computing interfaces (e.g., chatbots, wearables) to interact with customers, suppliers and employees?

How can you ensure that the intermediaries in your industry add more value than they extract?



# Weak signals



# Weak signals

The primary forces – technology, globalization and demographics – are the root causes of disruption. Since these primary forces are themselves evergreen, it is their evolution in new waves that creates disruptive megatrends and future working worlds.

Consider how recent waves of technology have created new megatrends. The online and mobile revolutions enabled the **super consumer**. Now, the next wave of technological disruption – human augmentation – is spawning a new generation of megatrends, such as the **future of work** and **adaptive regulation**.

To understand what lies beyond these disruptions – and find the seeds of tomorrow's megatrends – one needs to identify future primary force waves. To help with this process, we analyze “weak signals”, or waves of primary forces that are farther in the future.

Weak signals are nascent by definition. This means that the nature and magnitude of their impact is relatively unclear. It also means that they are rapidly evolving, with new weak signals emerging along the way.

For these reasons, we explore weak signals on our website rather than in this report. We expect to add new weak signals to our hub over time. Please check back regularly and join the conversation.

To learn more about weak signals, please visit: [ey.com/weaksignals](https://ey.com/weaksignals)

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- ▶ Connecting people and ideas in ways that are thought provoking, barrier breaking and future shaping.

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