2018 TECH TRENDS REPORT

Emerging technology trends that will influence business, government, education, media and society in the coming year.

Future Today Institute

THE YEAR AHEAD

Last year proved to be a restless nail-biter, and 2018 promises more of the same. Strap in, because you're likely to witness a number of events that don't appear to follow the familiar political, technological or business narratives.

Tantalizing advancements in emerging technologies–artificial intelligence, biotech, autonomous robots, green energy and space travel–will begin to enter the mainstream, which could eventually mean significant economic growth and healthier living. Yet a closer look reveals some alarming truths. The development of AI is our modern version of an arms race, and in 2018, China will lay the groundwork to become the world's unchallenged AI hegemon. If data is the new oil, China's massive, 730m online population puts it in control of our largest, and possibly most important natural resource going forward–human data–and it doesn't have the privacy and security restrictions that might hinder progress in other nations.

Meanwhile, this could be a breakthrough year for human genome editing, as experiments and trials exit the lab for real-world use. But we still lack a set of global norms and ethical standards for the clinical use of germline editing, even as newer techniques, such as human tissue engineering, are on the horizon. Scientists, security experts, ethicists and policymakers aren't doing long-range, data-driven forecasting. What if we create completely new biological life forms? Even if they're just blobs of tissue, would they be legally protected in any way? Would a blob of tissue have rights? Eventually, genome editing will allow us to grow healthy fruits, vegetables and grains in our homes. It could mean the end of food deserts and solve widespread hunger–and cause the collapse of our existing agricultural system, food supply chain, and global trade agreements.

But it does no good to map scenarios for the future without using historical context. This year marks some important anniversaries:

- Five years ago, internet activist Aaron Swartz, who helped make information move more freely via the RSS tool he helped create, committed suicide. His work to make academic research and public records freely available to the public resulted in federal charges carrying potential penalties of $1 million in fines and up to 35 years in prison. Aaron's suicide temporarily spurred debate, but it didn't result in constructive action on digital access and more modern methods of protecting intellectual property. In the coming year, we will see the emergence of a splintered internet, with new laws and regulations specific to geographic regions.

- It was 10 years ago that Apple launched its App Store, an innovation that catapulted smartphones from the fringe to the mainstream. Mobile apps ushered in the social media era, revolutionized the digital ad market, and blurred the lines between our workplaces and homes. Yet as smartphone sales have now plateaued, mobile phone makers and service providers have yet to define their next act as we head into a post-app, post-smartphone era.

- It's also been 10 years since Lehman Brothers filed for the largest bankruptcy in history, setting off a global financial crisis. In the years since, we've seen a crypotocurrency frenzy, ever-powerful high frequency trading algorithms and the effective dismantling of the Consumer Financial Protection Bureau in the U.S., which was created to help stave off the dangerous financial sector practices which led to the 2008 crash.

- And this year marks the 50th anniversary of the assassination of Dr. Martin Luther King, who was shot on a hotel balcony in Memphis, Tennessee. Yet America feels increasingly divided, in ways that are explicit (more white supremacist rallies are planned for 2018) and less obvious: roughly six-in-ten black STEM workers (62%) say they have experienced racial or ethnic discrimination at work, from earning less than a coworker who performed the same job to experiencing repeated, small slights.[1] Outside of the U.S., Austria's right-leaning chancellor, whose People's Party rose to prominence via social media and has aligned with former members of the Nazi party, will become the president of the European Union. (It's Austria's turn to hold the position.)

Like it or not, in 2018 leaders across all industries will confront difficult questions about the future of technology. They must do so using the context of history.

Now more than ever, every organization should examine the potential impact of tech trends—and leaders must be willing to take incremental actions. Whether you are a Fortune 500 company, a government agency, a start-up, a university, a foundation or a small business, you must factor the trends in this report into your strategic thinking for the coming year, and adjust your planning, operations and business models accordingly. Failing to track trends in a meaningful way will put your competitive advantage, growth and survivability at risk.

Helping organizations see change early and calculate the impact of new trends is why the Future Today Institute publishes its annual Tech Trends Report. Now in its 11th year, the report focuses on mid- to late-stage emerging technologies that are on a growth trajectory. We have identified more than 225 trends for the coming year across 20 industries, and that broad scope is intentional. To understand the future of technology, you must consider the past, present and future of all things. Otherwise, you're essentially looking at the world through a pinhole.

As of the publication date, The Future Today Institute's annual report has garnered more than six million cumulative views. We're glad to see so many leadership teams all around the world using these trends as part of a formal, ongoing process to reduce risk, harness new opportunities and drive change within their fields. Whether you're thinking about 2018 or 2168—or any time in between—remember that the future isn't yet written. You and your team have the power to build your preferred future, today.

Sincerely,

Amy Webb

Founder

The Future Today Institute

[1] *Pew Research Center, http://www.pewresearch.org/fact-tank/2018/01/10/black-stem-employees-perceive-a-range-of-race-related-slights-and-inequities-at-work. Last accessed January 10, 2018.*

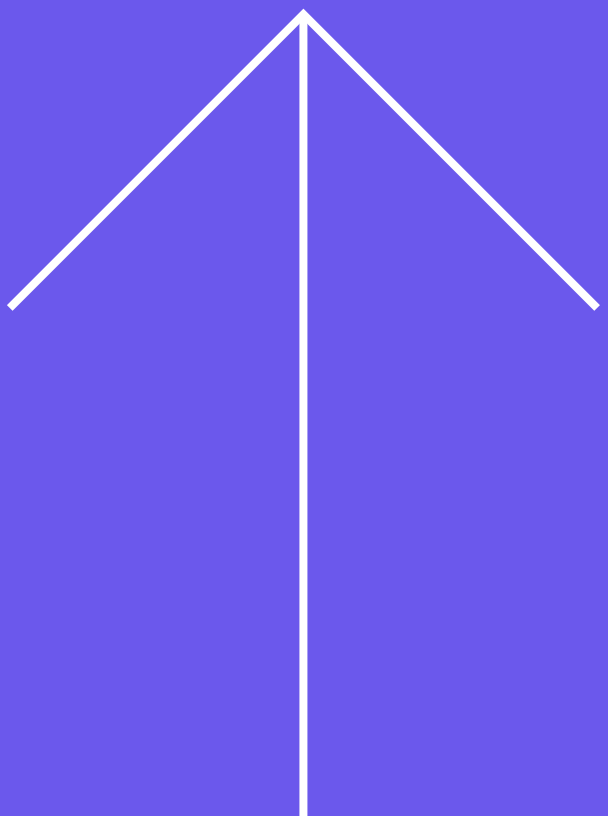
This is a robust, detailed report with more than 225 trends. Please don't try to read it in one sitting. Start with the Executive Summary, and then review the top tech trends listed for your industry. In the coming months, we hope that you'll spend time with all of the trends in our 2018 report, and that you'll allow your mind to wander productively.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Future Today Institute's 2018 Tech Trends Report is in its 11th year with more than 6 million cumulative views.

With 225 emerging trends worth following, this is our biggest Tech Trends Report yet. To us, this didn't come as a surprise. Technology begets technology. We are witnessing an explosion in slow motion.



KEY TAKEAWAYS

- **2018 marks the beginning of the end of traditional smartphones.** During the next decade, we will start to transition to the next era of computing and connected devices, which we will wear and will command using our voices, gesture and touch. The transition from smartphones to smart wearables and invisible interfaces–earbuds that have biometric sensors and speakers; rings and bracelets that sense motion; smart glasses that record and display information–will forever change how we experience the physical world. This doesn't necessarily signal a post-screen existence. We anticipate foldable and scrollable screens for portable, longer-form reading and writing.

- **Everyone should be paying extremely close attention to China.** The Chinese government is investing hundreds of billions of dollars into artificial intelligence, genomic editing, green technologies and renewable energy sources, smart farming systems and space exploration. To be fair, China has previously failed to deliver on similar bold investments and promises. This time around could be different, given the industrial policies already in play and Chinese-led advancements we're seeing across AI, genomics and renewables. China has been quietly and strategically acquiring U.S. tech secrets via joint ventures and minority investment structures, giving it a tactical business, geopolitical and military advantage over not just the U.S., but also Japan, Korea, and the E.U. No other country's government is racing towards the future with as much force and velocity as China, and this could signal big shifts in the balance of geopolitical power in the years ahead.

- **The artificial intelligence ecosystem—flooded with capital, hungry for commercial applications, and yet polluted with widespread, misplaced optimism and fear—will continue to swell.** You will see the AI ecosystem represented in many of the trends in this report, and it is vitally important that all decision-makers and teams familiarize themselves with current and emerging AI trends.

- **Policymakers won't be prepared to deal with new challenges that arise from emerging science and technology.** The tension between privacy and security will increase. As a result, we are likely to see regulations, rules and legislation that are either too restrictive or don't acknowledge that science and tech are in constant motion. This could mean big problems for tech giants and startups alike—not to mention everyday citizens all around the world.

- **In 2018, a critical mass of emerging technologies will converge. Every organization must look for connections between trends, rather than following individual trends themselves.** For example, why should a company like **Walmart** pay attention to the future of **CRISPR-Cas9**? Americans spend more than $550 billion on groceries each year, and in many communities, Walmart now doubles as the local grocery store. We know that extreme weather events will negatively impact farming and the supply chain. We also know that genome editing could yield drought-resistant, high-yield plants that require very little growing space or direct care. Walmart could become our primary source of affordable food in the future—or it could find itself disrupted by an agri-tech startup.

- **Decentralization emerged as a key theme for 2018.** Citing security concerns and infringements on intellectual property, some democratic governments around the world are restricting internet access and are banning certain content, effectively creating dozens of "splinternets." Sweeping changes to data privacy regulations, called the **General Data Protection Regulation (or GDPR)**, will take affect in the **European Union** this year. China is cracking down on virtual personal networks, while the U.S. debates whether or not to allow ISPs to collect and sell subscriber data, meter access and throttle connection speeds. All of this points to a new emphasis ways to circumvent traditional ISPs using private and peer-to-peer networks. How all of this plays out once our connected homes, cars, and wearables go online is still unclear.

- **Consolidation is also a key theme for 2018.** News brands, broadcast spectrum, and artificial intelligence startups will continue to be merged with and acquired by relatively few corporations. Pending legislation and policy in the U.S., E.U. and in parts of Asia could further concentrate the power among a small cadre of information and technology organizations in the year ahead.

SIGNALS FOR 2018

Your Guide To The Year Ahead

March

More than 100,000 techies, filmmakers, journalists, game designers and musicians gather in Austin, Texas for the annual South By Southwest festival.

April

Sovereign wealth fund managers, government leaders and business tycoons head to Los Angeles for the Milken Institute's Global Conference.

May

Sweeping changes to data privacy regulations take affect in the European Union. Dubbed the General Data Protection Regulation (or GDPR), the new rules affect how companies can collect and use customer data. Those who don't comply will face hefty fines and litigation. The GDPR applies to everyone who uses customer data, regardless of where in the world you are.

June

AI and autonomous vehicle researchers from around the world gather for several symposia in Stuttgart, Germany to debate and discuss the future of self-driving vehicles.

July

Tech, media and business moguls trek to Sun Valley, Idaho for Allen & Co.'s annual confab.

31-year-old Sebastian Kurz, Austria's right-leaning chancellor whose Austrian People's Party has aligned with former members of the Nazi party, becomes the president of the European Union. (It's Austria's turn to hold the position.)

August

The World Congress of Philosophy, held every five years since 1900, begins proceedings in Beijing, China. The theme for 2018 seems particularly ominous: "Learning To Be Human."

September

2018 is the year of the electric vehicle. This month, an all-electric Mini, whose parent company is BMW AG, will roll off the factory floor and into car dealerships. By then, Nissan will have launched its Leaf, joining Tesla Model 3 and the Chevrolet Bolt EV with affordable EVs in the market.

The 73rd session of the U.N. General Assembly will draw thousands of high-level government leaders to New York City for a week of talks.

October

The EU and UK have promised to complete their Brexit negotiations and final deal by October, so that the European Parliament has enough time to review and approve the terms before the U.K. officially leaves on March 29, 2019.

November

NASA's InSight robotic lander is expected to touch down on Mars and begin drilling.

The U.S. holds its midterm elections on November 6th, with a record number of women running for office, all 435 seats in the House of Representatives and a third of the Senate is up for grabs—not to mention the departure of several high-profile GOP officials announcing their retirement from politics.

Saudi Arabia says that it will sell a stake in Aramco, its massive state oil company, towards the end of 2018. It's a long-term strategy to help the kingdom diversify in a post-petrochemical economy.

December

Commercial spaceflight heads into higher orbit, as SpaceX transports the first two private citizens around the moon aboard its Falcon Heavy rocket.

Finland's two-year universal basic income experiment expires, with findings to be released in 2019.

January 2019

Newly-elected congresswomen and men begin their work in Washington, D.C.

The World Economic Forum Annual Meeting will be held January 22-25 in Davos-Klosters, Switzerland.

The Consumer Electronics Show, the world's largest convention for electronics and digital media, will be held January 8-11 in Las Vegas, Nevada.

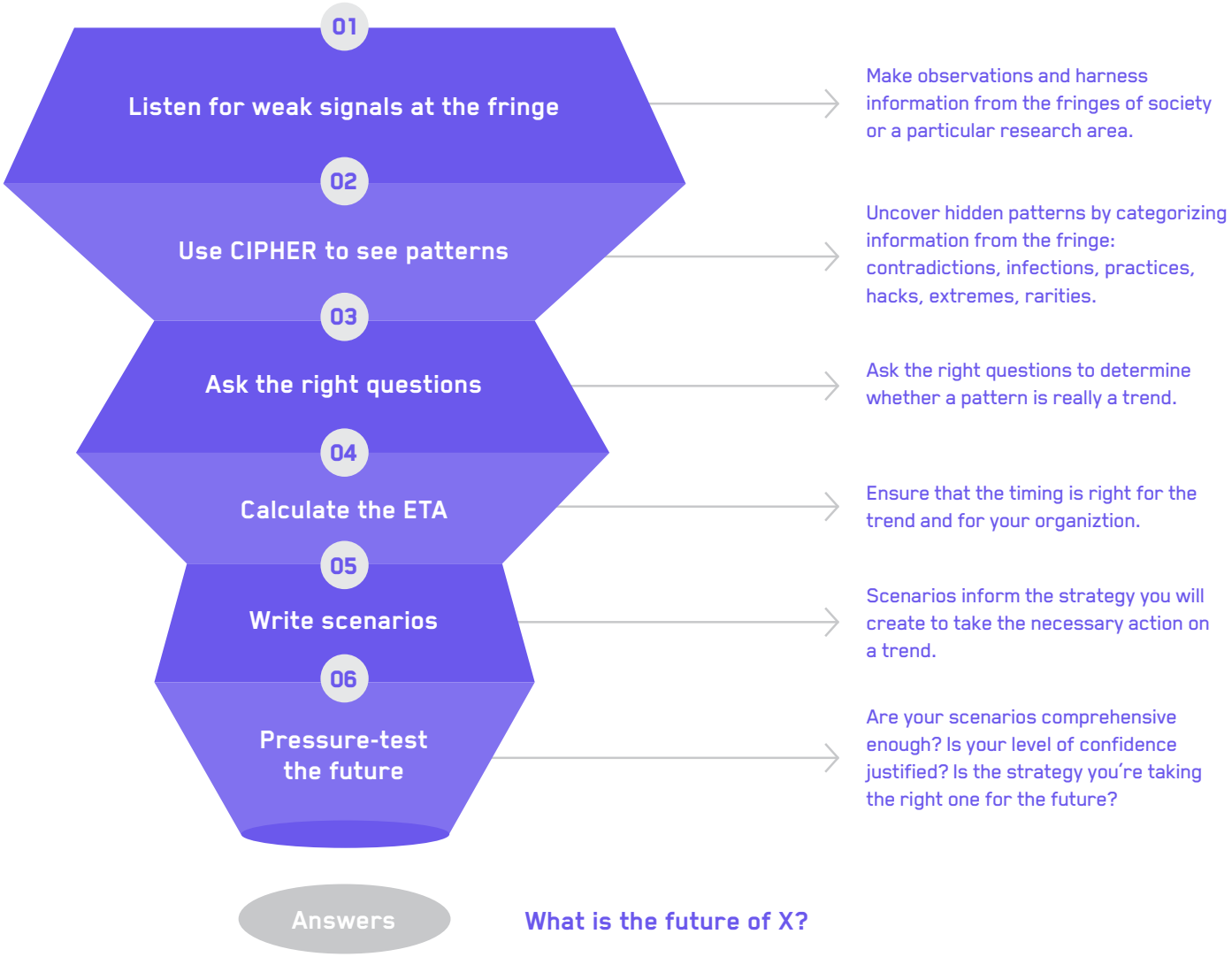
February 2019

The Mobile World Congress will be held in Europe.

METHODOLOGY

Forecasting Methodology: The Six-Step Funnel

The Future Today Institute's forecasting model uses quantitative and qualitative data to identify weak signals and map their trajectories into tech trends. Our six steps alternate between broad and narrow scopes, which include: identifying weak signals at the fringe, spotting patterns, interrogating trend candidates, calculating a trend's velocity, writing scenarios and finally pressure-testing strategies and recommendations.



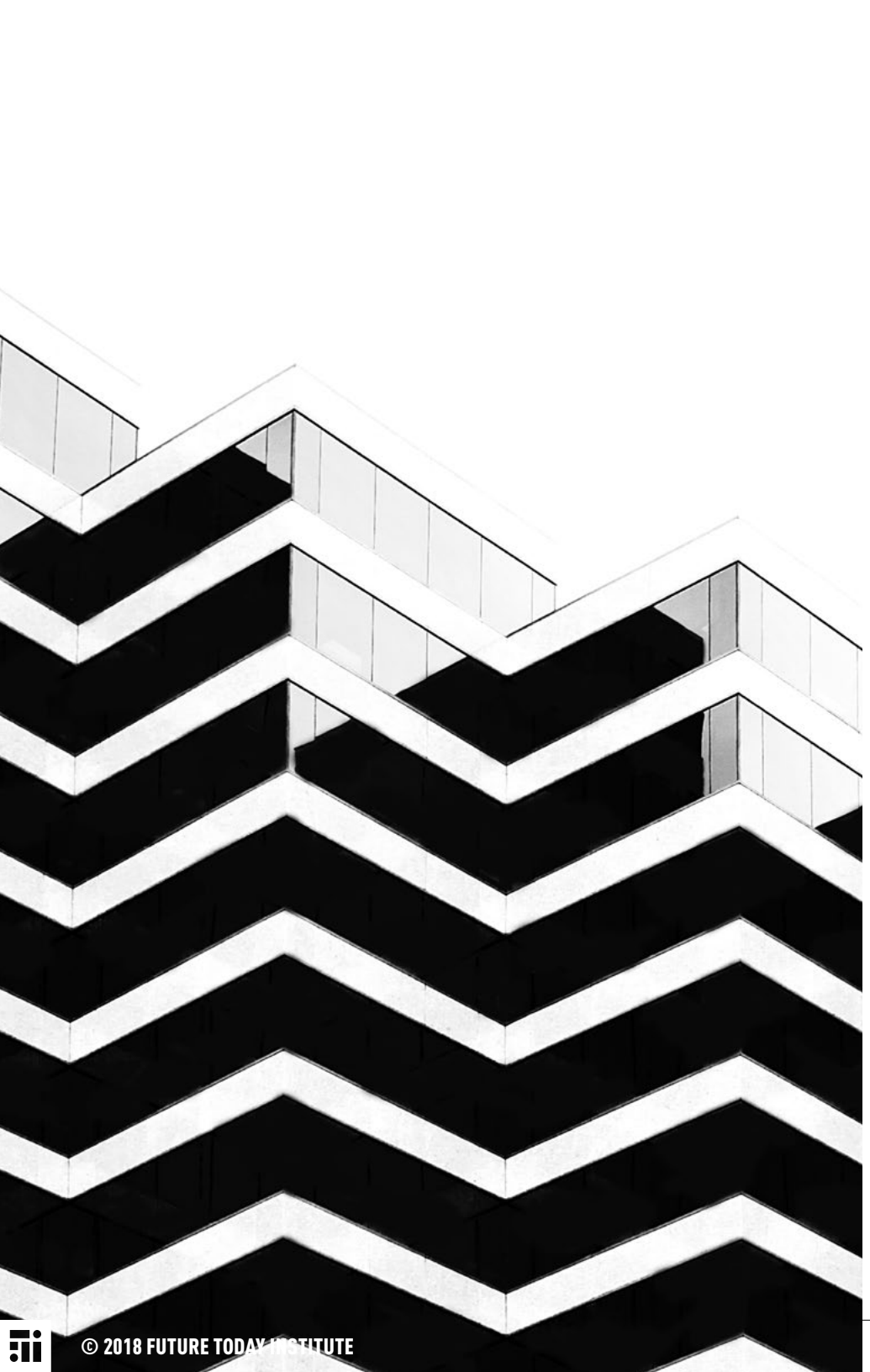
HOW TO USE THE 2018 TECH TRENDS REPORT IN YOUR ORGANIZATION

Our 2018 Trend Report reveals the strategic opportunities – and impending challenges – confronting your organization in the coming year.

The Future Today Institute's 11th annual Tech Trends Report prepares staff, managers, executives, funders and startups for the year ahead, so that they are better positioned to see technological disruption before it fully erupts. We encourage you to use our report as a tool to identify change and to learn how new technologies might impact your organization in the near-future. The Report is also a good source of potential new collaborators and partners. Most importantly, use our report as a jumping off point for deeper strategic planning.

Explaining why these trends matter.

Rather than simply offering an overview of the trends that will matter in 2018, this report takes the additional step of explaining why and how these trends will impact your organization. In some cases, we have also included plausible scenarios, to help you and your team envision the potential outcomes of these trends during the next 12 months.



DEPARTMENTS AND OFFICES THAT USE THE TREND REPORT

Our annual tech trend reports have garnered more than six million cumulative views. It is widely read in a variety of organizations worldwide, especially by the following departments and offices:

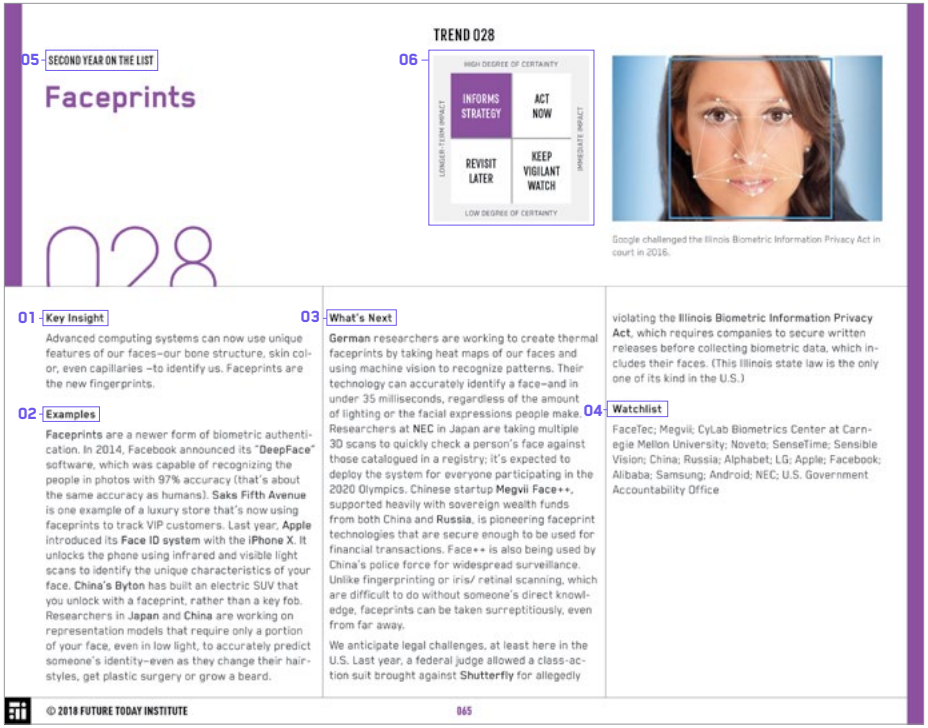
- Executive Management
- Strategic Planning
- R&D
- Foresight
- Board of Directors/ Board Management
- Strategic/ Venture Investment
- Policymaking
- Innovation
- Business Development
- Risk Management
- Product Design
- Marketing
- Workforce Development/ Education

HOW TO USE OUR REPORT

Each trend offers six important pieces of information for your organization.

The Future Today Institute's 11th annual Tech Trends Report prepares staff, managers, executives, funders and startups for the year ahead, so that they are better positioned to see technological disruption before it fully erupts. We encourage you to use our report as a tool to identify change and to learn how new technologies might impact your organization in the near-future. The Report is also a good source of potential new collaborators and partners. Most importantly, use our report as a jumping off point for deeper strategic planning.

We recommend using our 2018 Tech Trends Report as part of a formalized process to evaluate disruptive technologies throughout the year.



TREND 028

05 SECOND YEAR ON THE LIST

Faceprints

028

06

HIGH DEGREE OF CERTAINTY

INFORMS STRATEGY

ACT NOW

REVISIT LATER

KEEP VIGILANT WATCH

LOW DEGREE OF CERTAINTY

LONGER-TERM IMPACT

IMMEDIATE IMPACT

Google challenged the Illinois Biometric Information Privacy Act in court in 2016.

01 Key Insight

Advanced computing systems can now use unique features of our faces–our bone structure, skin color, even capillaries –to identify us. Faceprints are the new fingerprints.

02 Examples

Faceprints are a newer form of biometric authentication. In 2014, Facebook announced its "**DeepFace**" software, which was capable of recognizing the people in photos with 97% accuracy (that's about the same accuracy as humans). **Saks Fifth Avenue** is one example of a luxury store that's now using faceprints to track VIP customers. Last year, **Apple** introduced its **Face ID system** with the **iPhone X**. It unlocks the phone using infrared and visible light scans to identify the unique characteristics of your face. **China's Byton** has built an electric SUV that you unlock with a faceprint, rather than a key fob. Researchers in **Japan** and **China** are working on representation models that require only a portion of your face, even in low light, to accurately predict someone's identity–even as they change their hairstyles, get plastic surgery or grow a beard.

03 What's Next

German researchers are working to create thermal faceprints by taking heat maps of our faces and using machine vision to recognize patterns. Their technology can accurately identify a face–and in under 35 milliseconds, regardless of the amount of lighting or the facial expressions people make. Researchers at **NEC** in Japan are taking multiple 3D scans to quickly check a person's face against those catalogued in a registry; it's expected to deploy the system for everyone participating in the 2020 Olympics. Chinese startup **Megvii Face++**, supported heavily with sovereign wealth funds from both China and **Russia**, is pioneering faceprint technologies that are secure enough to be used for financial transactions. Face++ is also being used by China's police force for widespread surveillance. Unlike fingerprinting or iris/ retinal scanning, which are difficult to do without someone's direct knowledge, faceprints can be taken surreptitiously, even from far away.

We anticipate legal challenges, at least here in the U.S. Last year, a federal judge allowed a class-action suit brought against **Shutterfly** for allegedly violating the **Illinois Biometric Information Privacy Act**, which requires companies to secure written releases before collecting biometric data, which includes their faces. (This Illinois state law is the only one of its kind in the U.S.)

04 Watchlist

FaceTec; Megvii; CyLab Biometrics Center at Carnegie Mellon University; Noveto; SenseTime; Sensible Vision; China; Russia; Alphabet; LG; Apple; Facebook; Alibaba; Samsung; Android; NEC; U.S. Government Accountability Office

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01 Key Insight

Short, easy explanation of this trend so that you can internalize it and discuss with your colleagues.

02 Examples

Real-world use cases, some of which will sound familiar.

03 What's Next

What this trend means for you and your organization in the coming year.

04 Watchlist

These are the organizations and stakeholders most deeply involved in this trend.

05 Years On The List

We've noted how many years FTI has been tracking the trend in our annual Tech Trends Report, which began publication 11 years ago. This measurement is an indication of how the trend is evolving.

06 Action Meter

An easy-to-read graphic indicating where the trend is along its trajectory.
It tells you whether the trend needs monitoring, should inform your strategy, or requires action.

TEN IMPORTANT QUESTIONS

How to relate these trends to the work you do, and to your organization's growth, in 2018

Of the organizations we advise, we've seen the most success from those who form a cross-functional team to review our Tech Trend Report.

The best way to make practical use of this year's report is to ask and answer some fundamental questions about what these trends mean to your organization in the near-future. Don't discount a trend simply because at first glance it doesn't seem to connect directly to you or your field. As you'll see in the scenarios that follow, often it's those technologies in completely unrelated fields that cause the most disruption.

10

01 How does this trend impact our industry and all of its parts?

02 How might global events – politics, climate change, economic shifts – impact this trend, and as a result, our organization?

03 What are the second, third, fourth, and fifth-order implications of this trend as it evolves, both in our organization and our industry?

04 What are the consequences if our organization fails to take action on this trend?

05 Does this trend signal emerging disruption to our traditional business practices and cherished beliefs?

06 Does this trend indicate a future disruption to the established roles and responsibilities within our organization? If so, how do we reverse-engineer that disruption and deal with it in the present day?

07 How are the organizations in adjacent spaces addressing this trend? What can we learn from their failures and best practices?

08 How will the wants, needs and expectations of our consumers/ constituents change as a result of this trend?

09 Where does this trend create potential new partners or collaborators for us?

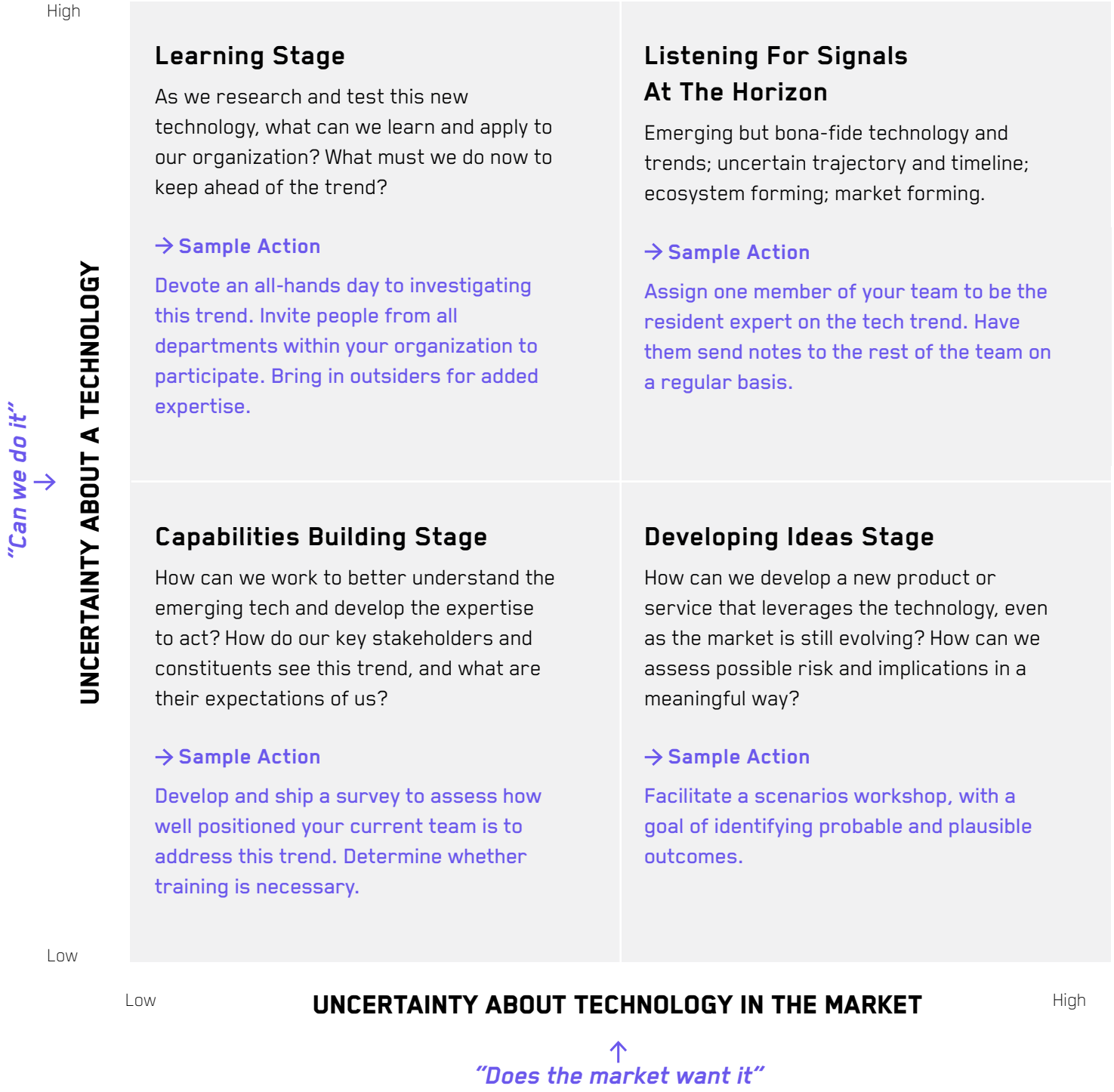
10 How does this trend inspire us to think about the future of our organization?

WHEN, EXACTLY, TO TAKE ACTION ON TECH TRENDS

We encourage you to use our Tech Trends Report as the basis for strategic meetings – as long as you commit to taking incremental action right away. Many organizations prefer to take a "wait and see" approach after seeing new research, and that's a mistake. Your team must take some action, even if it's small, to build momentum so that you may confront the future on your own terms.

The Future Today Institute created a simple framework for our clients to help them continually monitor technology as it moves from the fringe to the mainstream. Incremental actions position an organization to make smarter strategic decisions in advance, rather than trying to play catch-up after a disastrous event.

This is our framework, and we encourage your organization to use it as you read through our report.


High
Learning Stage
As we research and test this new technology, what can we learn and apply to our organization? What must we do now to keep ahead of the trend?
→ Sample Action
Devote an all-hands day to investigating this trend. Invite people from all departments within your organization to participate. Bring in outsiders for added expertise.
Listening For Signals At The Horizon
Emerging but bona-fide technology and trends; uncertain trajectory and timeline; ecosystem forming; market forming.
→ Sample Action
Assign one member of your team to be the resident expert on the tech trend. Have them send notes to the rest of the team on a regular basis.
"Can we do it" →
UNCERTAINTY ABOUT A TECHNOLOGY
Capabilities Building Stage
How can we work to better understand the emerging tech and develop the expertise to act? How do our key stakeholders and constituents see this trend, and what are their expectations of us?
→ Sample Action
Develop and ship a survey to assess how well positioned your current team is to address this trend. Determine whether training is necessary.
Developing Ideas Stage
How can we develop a new product or service that leverages the technology, even as the market is still evolving? How can we assess possible risk and implications in a meaningful way?
→ Sample Action
Facilitate a scenarios workshop, with a goal of identifying probable and plausible outcomes.
Low
Low
UNCERTAINTY ABOUT TECHNOLOGY IN THE MARKET
High
↑
"Does the market want it"

OUR TRENDS AREN'T TRENDY

Before the description of each trend, you'll see how many years it has been on our list. The trends that futurists research are never shiny, flashes in the pan. As you'll see, the trends in our report are not trendy. (At least, not intentionally.) Instead, they emerge from weak signals at the fringe and reveal changes afoot. Real trends tend to take shape over many years. We use trends to help us see potential opportunities, challenges and plausible scenarios for next-order impacts.

A trend is a new manifestation of sustained change within an industry sector, society, or human behavior.

Fundamentally, a trend leverages our basic human needs and desires in a meaningful way, and it aligns human nature with breakthrough technologies and inventions.

The Four Laws of Technology Trends

All technology trends share a set of four conspicuous, universal features.

- Tech trends are the convergence of weak signals from the fringe.
- Tech trends are driven by basic human needs.
- Tech trends evolve as they emerge.
- Tech trends are timely, but they persist.

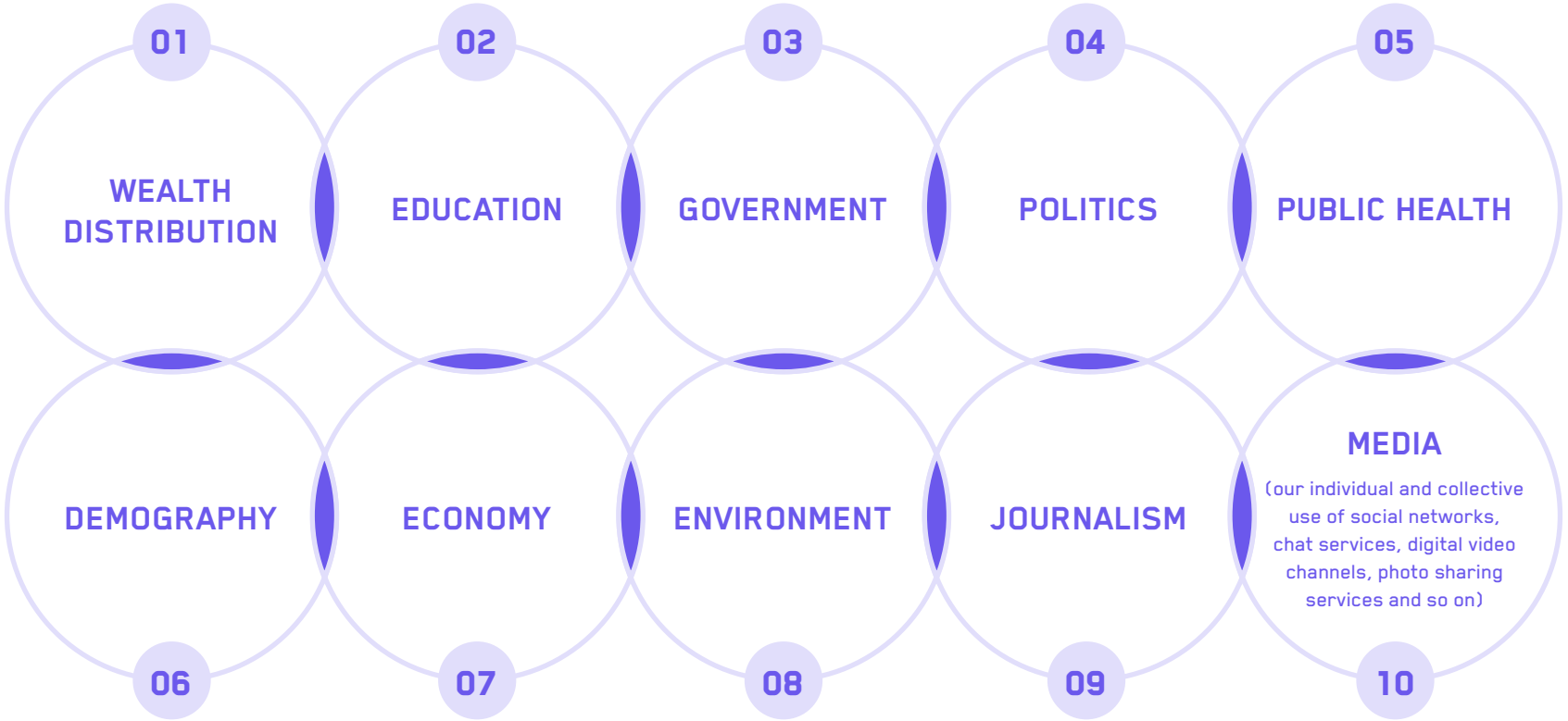
At any moment, there are thousands of small shifts in technology—developments on the fringes of science and society—that will impact our lives in the future.

The Four Laws of Technology Trends were first published in *The Signals Are Talking: Why Today's Fringe Is Tomorrow's Mainstream*, by Amy Webb.

THE 10 SOURCES OF ALL FUTURE CHANGE

To understand the future of one thing, you must consider the future of all things. Otherwise, you're essentially looking at the world through a pinhole.

Historically, the sources of all future change tend to come from the 10 primary sources you see below. Technological advancement influences future changes and disruption across fields and industries. When FTI researches tech trends, we do so using the prism of these sources.



THE MOST IMPORTANT TECH TRENDS FOR YOUR INDUSTRY AND ORGANIZATION

We've curated lists to help you quickly identify the most important tech trends that will matter to your team, organization and industry in 2018. For your convenience, industries are listed alphabetically along with their corresponding key themes and trends.

ADVERTISING, MARKETING AND PUBLIC RELATIONS

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Personal and One-To-Few Networks

Organizational Doxing

Digital Self-Incrimination

Natural Language Generation for Reading Levels

Computational Photography

Computational Journalism

I-Teams For Algorithms and Data

Voice Interfaces For News and Books

Proximity News

Crowdlearning

Digital Frailty

Radical Transparency

Limited-Edition News Products

One-To-Few Publishing

Notification Layer (A Tragedy of the Commons)

Transparency in Metrics

Real-Time Fact Checking

Offline Is The New Online

Audio Search Engines

Synthetic Data Sets

Connected TVs

Decentralizing The Web

Streaming Social Video

New Video and Audio Story Formats

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Mixed Reality Arcades

MMOMRGs

VR For Marketing

AI For the Creative Process

FOBO

Retail APIs

Digital Associates

Patient-Generated Health Data

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smartwatches

Privacy Laws

Net Neutrality

Internet of Things

Intelligent Cameras

Our Appliances Will Have Digital Assistants

Smart Appliance Screens Are Coming

Home Appliances Will Talk To Each Other

AI in Hiring

Productivity Bots

Adaptive Learning

Splinternets

Election Security

Old Laws Clash With New Technology

AGRICULTURE

Pay Special Attention To These Trends

Indoor and Outdoor Plant Factories and Microfarms

Deep Learning For Farming and Food Recognition

Smart Farms

Terraforming

Cultivated Food and Beverage

Genome Editing

Biological DVRs

Custom-Crafted Microbes

Genome Editing Research Clashes With Public Opinion

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smartwatches

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Universal Basic Income

Nanodegrees

Sharing Economy & Lendership

CubeSats

Intelligent Cameras

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

Deep Linking Everywhere

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

Right To Eavesdrop/ Be Eavesdropped On

Drone Surveillance

Self-Assembling Robots

Robot Compilers

Collaborative Robotics

Smart Dust

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Augmented Reality

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

ARCHITECTURE, CITY MANAGEMENT AND URBAN PLANNING

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Organizational Doxing

Eye In The Sky

Data Retention Policies

Encryption Management

Self-Assembling Robots

Robot Compilers

Smart Dust

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Holograms

Virtual Reality

360-degree Video

Augmented Reality

AI For the Creative Process

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Indoor and Outdoor Plant Factories and Microfarms

Terraforming

Privacy Laws

Net Neutrality

Internet of Things

Our Appliances Will Have Digital Assistants

Smart Appliance Screens Are Coming

Home Appliances Will Talk To Each Other

Wireless Kitchens

Smarter Home Security

Smart Remotes

Smart Mirrors

Our Smarthomes Become Weaponized

Sharing Economy & Lendership

Blockchain

Smart City Initiatives

Faster Connectivity With 5G

City-Level Cyber Security

Splinternets

CubeSats

AUTO MANUFACTURERS

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Organizational Doxing

Differential Privacy

Digital Self-Incrimination

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Self-Assembling Robots

Robot Compilers

Molecular Robotics

Collaborative Robotics

Ethical Manufacturing

Soft Robotics

Human-Machine Interfaces

Smart Dust

Personal Robots and Butlers

Robot Abuse

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Smart Helmets

Smart Gloves

Smartwatches

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Smart Mirrors

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

Old Laws Clash With New Technology

"Unhackable" Computers

Brain-To-Vehicle Interfaces

BANKING

Pay Special Attention To These Trends

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Open Banking

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Data Retention Policies

Encryption Management

Global Data Scientist Shortages

Privacy Laws

Net Neutrality

Faster Connectivity With 5G

Quantum Computers

"Unhackable" Computers

Alt-Cryptocurrencies

COLLEGES, UNIVERSITIES AND SCHOOLS

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Personal and One-To-Few Networks

Leaking

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Revenge Porn

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Personal Robots and Butlers

Robot Abuse

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Natural Language Generation for Reading Levels

Computational Photography

The First Amendment in a Digital Age

Virtual Reality

360-degree Video

Augmented Reality

VR For Marketing

AI For the Creative Process

FOBO

Extreme Weather Events

Human Migration Patterns Shift

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Blockchain

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

CONSTRUCTION AND BUILDING TRADES

Pay Special Attention To These Trends

Drone Surveillance

Self-Assembling Robots

Robot Compilers

Collaborative Robotics

Smart Dust

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Augmented Reality

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smartwatches

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Universal Basic Income

Nanodegrees

Sharing Economy & Lendership

CubeSats

Intelligent Cameras

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

Deep Linking Everywhere

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

Right To Eavesdrop/ Be Eavesdropped On

CORPORATE BOARDS AND DIRECTORS

Pay Special Attention To These Trends

The AI Cloud

More Consolidation in AI

Digital Assistants Become Ubiquitous

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

New Infrastructure Targets

Hacktivism On The Rise

Strange Computer Glitches Will Keep Happening

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Organizational Doxing

Data Retention Policies

Encryption Management

Global Data Scientist Shortages

Ethical Manufacturing

I-Teams For Algorithms and Data

Digital Frailty

Media Consolidation

Green Tech

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Genome Editing

Privacy Laws

Net Neutrality

Universal Basic Income

AI in Hiring

Sharing Economy & Lendership

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Quantum Computers

"Unhackable" Computers

CPG AND RETAIL

Pay Special Attention To These Trends

Artificial Intelligence

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

Hacktivism On The Rise

Backdoors

Targeted Attacks on Digital Assistants

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Blocking the Ad Blockers

Organizational Doxing

Differential Privacy

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Ethical Manufacturing

3D Printing

VR For Marketing

AI For the Creative Process

FOBO

Retail APIs

Digital Associates

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Cultivated Food and Beverage

Wearables

Privacy Laws

Net Neutrality

Internet of Things

Sharing Economy & Lendership

Social Payments

Cryptocurrencies

Blockchain

Faster Connectivity With 5G

DEFENSE AND NATIONAL SECURITY

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Self-Assembling Robots

Robot Compilers

Molecular Robotics

Collaborative Robotics

Soft Robotics

Human-Machine Interfaces

Smart Dust

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Holograms

Virtual Reality

360-degree Video

Augmented Reality

MMOMRGs

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Genome Editing

Biological DVRs

Human DNA-Powered Devices

Using Our DNA As Hard Drives

Touch-Sensitive Prosthetics

Smart Thread

Bioelectronics

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smart Bras

Smart Helmets

Smart Gloves

Tattooables

Thinkables

Ingestables

Smartwatches

Smart Shoes

Wireless Body Area Networks

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Nanodegrees

Cryptocurrencies

Blockchain

Faster Connectivity With 5G

Splinternets

Election Security

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

Commercial Space Flight

CubeSats

Asteroid Mining For Resources

Space Exploration

Quantum Computers

"Unhackable" Computers

Brain-To-Vehicle Interfaces

Brain-To-Internet Interfaces

Alt-Cryptocurrencies

Adaptive Camouflage

Robot Vision

DOCTORS AND OTHER HEALTH PROFESSIONALS

Pay Special Attention To These Trends

The AI Cloud

More Consolidation in AI

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

Who Owns Your Personal, Biometric Data?

Molecular Robotics

Soft Robotics

Human-Machine Interfaces

3D Printing

Virtual Reality

Augmented Reality

FOBO

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Genome Editing

Biological DVRs

Human DNA-Powered Devices

Using Our DNA As Hard Drives

Nanobot Nurses

Custom-Crafted Microbes

Precision Medicine Just For You

Running Out Of Space For Genome Storage

Genome Editing Research Clashes With Public Opinion

Nootropics and Neuroenhancers

Microbiome Extinction

Building A Comprehensive Human Cell Atlas

Biointerfaces Laminated Onto Our Skin

Patient-Generated Health Data

Touch-Sensitive Prosthetics

Smart Thread

Bioelectronics

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smart Bras

Smart Helmets

Smart Gloves

Tattooables

Thinkables

Ingestables

Smart Fabrics

Smartwatches

Smart Shoes

Wireless Body Area Networks

Privacy Laws

Net Neutrality

Internet of Things

Blockchain

Faster Connectivity With 5G

Old Laws Clash With New Technology

Brain-To-Internet Interfaces

DRUG MANUFACTURERS/ PHARMACEUTICALS

Pay Special Attention To These Trends

The AI Cloud

More Consolidation in AI

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

Who Owns Your Personal, Biometric Data?

Molecular Robotics

Soft Robotics

Human-Machine Interfaces

3D Printing

Virtual Reality

Augmented Reality

VR For Marketing

AI For the Creative Process

FOBO

Retail APIs

Digital Associates

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Genome Editing

Biological DVRs

Human DNA-Powered Devices

Using Our DNA As Hard Drives

Nanobot Nurses

Custom-Crafted Microbes

Precision Medicine Just For You

Running Out Of Space For Genome Storage

Genome Editing Research Clashes With Public Opinion

Nootropics and Neuroenhancers

Microbiome Extinction

Building A Comprehensive Human Cell Atlas

Biointerfaces Laminated Onto Our Skin

Patient-Generated Health Data

Touch-Sensitive Prosthetics

Smart Thread

Bioelectronics

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smart Bras

Smart Helmets

Smart Gloves

Tattooables

Thinkables

Ingestables

Smart Fabrics

Smartwatches

Smart Shoes

Wireless Body Area Networks

Privacy Laws

Net Neutrality

Internet of Things

Blockchain

Faster Connectivity With 5G

Old Laws Clash With New Technology

Brain-To-Internet Interfaces

ENERGY

Pay Special Attention To These Trends

Artificial Intelligence

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

Self-Assembling Robots

Robot Compilers

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

ENTERTAINMENT MEDIA AND FILM

Pay Special Attention To These Trends

Artificial Intelligence

Gesture Recognition

Offline Is The New Online

Audio Search Engines

Decentralizing The Web

Streaming Social Video

New Video and Audio Story Formats

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Mixed Reality Arcades

MMOMRGs

AI For the Creative Process

FOBO

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

Hacktivism On The Rise

Strange Computer Glitches Will Keep Happening

The General Data Protection Regulation Takes Effect

Leaking

Blocking the Ad Blockers

Organizational Doxing

Data Retention Policies

Encryption Management

Wearables

Smart Mirrors

Faster Connectivity With 5G

Splinternets

FINANCE AND FINTECH

Pay Special Attention To These Trends

Artificial Intelligence

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Open Banking

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

The AI Cloud

Proprietary, Homegrown AI

Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Data Retention Policies

Encryption Management

Global Data Scientist Shortages

Privacy Laws

Net Neutrality

Faster Connectivity With 5G

Quantum Computers

"Unhackable" Computers

Alt-Cryptocurrencies

FOUNDATIONS, PHILANTHROPISTS AND NONPROFITS

Pay Special Attention To These Trends

Artificial Intelligence

Hidden Bias in Recognition Technologies

Ethical Manufacturing

Robot Abuse

Flying Taxis

Drone Delivery

Drone Lanes

Autonomous Vehicle Testing In Cities Around the U.S.

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Natural Language Generation for Reading Levels

Computational Photography

Computational Journalism

I-Teams For Algorithms and Data

Voice Interfaces For News and Books

Crowdlearning

Digital Frailty

Radical Transparency

Decentralizing The Web

Streaming Social Video

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Holograms

Virtual Reality

360-degree Video

Augmented Reality

AI For the Creative Process

FOBO

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Genome Editing

Wearables

Privacy Laws

Net Neutrality

Internet of Things

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Open Banking

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

Old Laws Clash With New Technology

GOVERNMENT AND POLITICS (NATIONAL AND INTERNATIONAL)

Pay Special Attention To These Trends

Artificial Intelligence

Faster Connectivity With 5G

Splinternets

Election Security

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

Commercial Space Flight

CubeSats

Asteroid Mining For Resources

Space Exploration

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Open Banking

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Privacy Laws

Net Neutrality

Internet of Things

Our Smarthomes Become Weaponized

Patient-Generated Health Data

Genome Editing

Genome Editing Research Clashes With Public Opinion

Indoor and Outdoor Plant Factories and Microfarms

Deep Learning For Farming and Food Recognition

Smart Farms

Terraforming

Cultivated Food and Beverage

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

FOBO

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Robot Abuse

Ethical Manufacturing

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Quantum Computers

"Unhackable" Computers

Brain-To-Vehicle Interfaces

Brain-To-Internet Interfaces

GOVERNMENT AND POLITICS (LOCAL)

Pay Special Attention To These Trends

Artificial Intelligence

Smart City Initiatives

Faster Connectivity With 5G

City-Level Cyber Security

Splinternets

Election Security

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

Blockchain

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Privacy Laws

Net Neutrality

Internet of Things

Our Smarthomes Become Weaponized

Indoor and Outdoor Plant Factories and Microfarms

Smart Farms

Terraforming

CubeSats

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Proximity News

Crowdlearning

Digital Frailty

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

HOSPITALITY

Pay Special Attention To These Trends

Artificial Intelligence

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Personal Robots and Butlers

Robot Abuse

3D Printing

Flying Taxis

Drone Delivery

Drone Lanes

Solar Highways

Supersonic Flights

Connected TVs

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Mixed Reality Arcades

VR For Marketing

AI For the Creative Process

FOBO

Retail APIs

Digital Associates

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Cultivated Food and Beverage

Wearables

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Our Appliances Will Have Digital Assistants

Smart Appliance Screens Are Coming

Home Appliances Will Talk To Each Other

Wireless Kitchens

Universal Basic Income

AI in Hiring

Sharing Economy & Lendership

Social Payments

Faster Connectivity With 5G

Blockchain

Commercial Space Flight

CubeSats

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

INFRASTRUCTURE

Pay Special Attention To These Trends

Artificial Intelligence

Smart City Initiatives

Faster Connectivity With 5G

City-Level Cyber Security

Splinternets

Election Security

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

Blockchain

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Privacy Laws

Net Neutrality

Internet of Things

Our Smarthomes Become Weaponized

Indoor and Outdoor Plant Factories and Microfarms

Smart Farms

Terraforming

CubeSats

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Proximity News

Crowdlearning

Digital Frailty

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

LAW ENFORCEMENT

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Smart Dust

3D Printing

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Holograms

Virtual Reality

360-degree Video

Augmented Reality

MMOMRGs

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smart Helmets

Smart Gloves

Smartwatches

Smart Shoes

Wireless Body Area Networks

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Nanodegrees

Cryptocurrencies

Blockchain

Faster Connectivity With 5G

Splinternets

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

CubeSats

Quantum Computers

"Unhackable" Computers

Alt-Cryptocurrencies

Adaptive Camouflage

Robot Vision

LAWYERS, LAW FIRMS AND LEGAL INDUSTRY

Pay Special Attention To These Trends

Artificial Intelligence

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

More Cyber Mission Forces in the Field

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Drone Surveillance

Personal and One-To-Few Networks

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

Anti-Recognition Cammo and Glasses

Digital Self-Incrimination

SWATting at Trolls

Revenge Porn

Eye In The Sky

Law Enforcement Using Recognition Algorithms To ID Faces

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

Robot Abuse

Personal Home Drone Surveillance

Cars as Interfaces

Autonomous Vehicle Legislation

I-Teams For Algorithms and Data

Crowdlearning

Digital Frailty

Real-Time Fact Checking

Offline Is The New Online

Audio Search Engines

Synthetic Data Sets

Decentralizing The Web

Streaming Social Video

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

AI For the Creative Process

FOBO

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Genome Editing

Genome Editing Research Clashes With Public Opinion

Patient-Generated Health Data

Wearables

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Our Smarthomes Become Weaponized

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Open Banking

Faster Connectivity With 5G

City-Level Cyber Security

Splinternets

Election Security

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Overhauling Government Tech Infrastructure

Quantum Computers

"Unhackable" Computers

Alt-Cryptocurrencies

MANUFACTURING

Pay Special Attention To These Trends

Artificial Intelligence

Self-Assembling Robots

Robot Compilers

Molecular Robotics

Collaborative Robotics

Ethical Manufacturing

Soft Robotics

Human-Machine Interfaces

Smart Dust

Personal Robots and Butlers

Robot Abuse

3D Printing

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Geoengineering

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

MEDICAL, HEALTH AND LIFE SCIENCES

Pay Special Attention To These Trends

Artificial Intelligence

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Molecular Robotics

Soft Robotics

Human-Machine Interfaces

Smart Dust

Personal Robots and Butlers

Robot Abuse

3D Printing

Natural Language Generation for Reading Levels

Computational Photography

Crowdlearning

Synthetic Data Sets

Holograms

Virtual Reality

360-degree Video

Augmented Reality

FOBO

Retail APIs

Digital Associates

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

Cultivated Food and Beverage

Deep Learning For Farming and Food Recognition

Genome Editing

Biological DVRs

Human DNA-Powered Devices

Using Our DNA As Hard Drives

Nanobot Nurses

Custom-Crafted Microbes

Precision Medicine Just For You

Running Out Of Space For Genome Storage

Genome Editing Research Clashes With Public Opinion

Nootropics and Neuroenhancers

Microbiome Extinction

Building A Comprehensive Human Cell Atlas

Biointerfaces Laminated Onto Our Skin

Patient-Generated Health Data

Touch-Sensitive Prosthetics

Smart Thread

Bioelectronics

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smart Bras

Smart Helmets

Smart Gloves

Tattooables

Thinkables

Ingestables

Smart Fabrics

Smartwatches

Smart Shoes

Wireless Body Area Networks

Privacy Laws

Net Neutrality

Internet of Things

Universal Basic Income

Nanodegrees

Blockchain

Faster Connectivity With 5G

Splinternets

Old Laws Clash With New Technology

Quantum Computers

“Unhackable” Computers

Brain-To-Vehicle Interfaces

Brain-To-Internet Interfaces

NEWS MEDIA AND BOOK PUBLISHING

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China’s AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Personal and One-To-Few Networks

Organizational Doxing

Digital Self-Incrimination

Natural Language Generation for Reading Levels

Computational Photography

Computational Journalism

I-Teams For Algorithms and Data

Voice Interfaces For News and Books

Proximity News

Crowdlearning

Digital Frailty

Radical Transparency

Limited-Edition News Products

One-To-Few Publishing

Notification Layer (A Tragedy of the Commons)

Transparency in Metrics

Real-Time Fact Checking

Offline Is The New Online

Audio Search Engines

Synthetic Data Sets

Journalism as a Service (JaaS)

Connected TVs

Decentralizing The Web

Streaming Social Video

New Video and Audio Story Formats

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Mixed Reality Arcades

AI For the Creative Process

Patient-Generated Health Data

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smartwatches

Privacy Laws

Net Neutrality

Internet of Things

Intelligent Cameras

AI in Hiring

Productivity Bots

Adaptive Learning

Splinternets

Election Security

Old Laws Clash With New Technology

REAL ESTATE AND DEVELOPMENT

Pay Special Attention To These Trends

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

TECHNOLOGY COMPANIES AND DIGITAL PLATFORMS

Pay Special Attention To These Trends

The AI Cloud

Proprietary, Homegrown AI Languages

AI Chipsets

Cognitive Computing

Bots

Marketplaces For AI Algorithms

More Consolidation in AI

Consumer-Grade AI Applications Debut

Digital Assistants Become Ubiquitous

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Making AI Explain Itself

Accountability and Trust

Hidden Bias Leads To Big Problems

China's AI Boom

Real-Time Machine Learning

Natural Language Understanding

Machine Reading Comprehension

Natural Language Generation

Generative Algorithms For Voice, Sound and Video

Image Completion

Predictive Machine Vision

Much Faster Deep Learning

Reinforcement Learning and Hierarchical RL

Continuous Learning

Multitask Learning

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Hidden Bias in Recognition Technologies

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Russia's Gifted Hacker Community Grows

New Infrastructure Targets

Hacktivism On The Rise

Third-Party Verified Identities

Targeted Attacks on Digital Assistants

Zero-Knowledge Proofs Go Commercial

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Offensive Government Hacking

Strange Computer Glitches Will Keep Happening

Proliferation of Darknets, Aided By Cryptocurrencies

New Open Source App Vulnerabilities

Selfie Security Using Faceprints

Bounty Programs

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Defining What Constitutes Online Harassment

Leaking

Blocking the Ad Blockers

Organizational Doxing

Anonymity

Authenticity

Differential Privacy

SWATting at Trolls

Revenge Porn

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Global Data Scientist Shortages

I-Teams For Algorithms and Data

Voice Interfaces For News and Books

Proximity News

Crowdlearning

Digital Frailty

Radical Transparency

Transparency in Metrics

Connected TVs

Decentralizing The Web

Streaming Social Video

Media Consolidation

Social Tweaks To Social Network Algorithms

The First Amendment in a Digital Age

Holograms

Virtual Reality

360-degree Video

Augmented Reality

Mixed Reality Arcades

MMOMRGs

VR For Marketing

AI For the Creative Process

FOBO

Green Tech

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Smartwatches

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Our Appliances Will Have Digital Assistants

Smart Appliance Screens Are Coming

Home Appliances Will Talk To Each Other

Smart Mirrors

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Faster Connectivity With 5G

Splinternets

Election Security

Anti-Trust Lawsuits

Old Laws Clash With New Technology

Digital Caliphate

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

Quantum Computers

"Unhackable" Computers

Brain-To-Vehicle Interfaces

Brain-To-Internet Interfaces

Alt-Cryptocurrencies

TRADE ASSOCIATIONS, PROFESSIONAL ASSOCIATIONS, INTEREST GROUPS AND LOBBYISTS

Pay Special Attention To These Trends

Artificial Intelligence

Compliance Challenges and Unrealistic Budgets

DDoS Attacks Will Increase

Ransomware As A Service

Hacktivism On The Rise

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Leaking

Organizational Doxing

TRAVEL

Pay Special Attention To These Trends

The AI Cloud

Cognitive Computing

Bots

A Bigger Role For Ambient Interfaces

Deep Linking Everywhere

Generative Algorithms For Voice, Sound and Video

Image Completion

Adversarial Machine Learning

Faceprints

Voiceprints

WiFi Tracking

Gesture Recognition

Personality and Character Recognition

Ambient Proximity

Hidden Bias in Recognition Technologies

Hacktivism On The Rise

Targeted Attacks on Digital Assistants

Backdoors

Remote Kill Switches

AI-Powered Automated Hacking

Selfie Security Using Faceprints

The General Data Protection Regulation Takes Effect

Right To Eavesdrop/ Be Eavesdropped On

Drone Surveillance

Data Retention Policies

Encryption Management

Who Owns Your Personal, Biometric Data?

Flying Taxis

Autonomous Underwater Vehicles

Drone Delivery

Drone Lanes

Personal Home Drone Surveillance

Sense And Avoid Technology

Microdrones

Drone Swarms

Clandestine, Disappearing Drones

Autonomous Vehicle Testing In Cities Around the U.S.

Armchair AV Mechanics

Assisted Driving Before Full Automation

Adaptive Driving Systems

Vehicle-to-Vehicle (V2V) Communications

Electric Vehicles

Cars as Interfaces

Solar Highways

Autonomous Vehicle Legislation

Flying Cars

Supersonic Flights

Autonomous Ships

Green Tech

Charging Stations

Ultra-High-Voltage Direct Current and Macro Grids

Better Batteries

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Wearables

Smart Glasses

Hearables / Earables

Head Mounted Displays

Smartwatches

Smart Shoes

Privacy Laws

Net Neutrality

Internet of Things

Searching The Internet of Physical Things

Intelligent Cameras

Our Appliances Will Have Digital Assistants

Smart Appliance Screens Are Coming

Home Appliances Will Talk To Each Other

Wireless Kitchens

Smarter Home Security

Smart Remotes

Smart Mirrors

Our Smarthomes Become Weaponized

Sharing Economy & Lendership

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

Digital Caliphate

Commercial Space Flight

Space Exploration

Robot Vision

WORK (FUTURE OF)

Pay Special Attention To These Trends

Universal Basic Income

AI in Hiring

Productivity Bots

Adaptive Learning

Nanodegrees

Sharing Economy & Lendership

Privacy Laws

Net Neutrality

E-Resident and Location-Independent Digital Business Identity Cards

Social Payments

Cryptocurrencies

Blockchain

Smart City Initiatives

Faster Connectivity With 5G

Splinternets

Anthropocene

Extreme Weather Events

Human Migration Patterns Shift

Ransomware As A Service

Hacktivism On The Rise

Zero-Day Exploits On The Rise

Backdoors

Remote Kill Switches

Strange Computer Glitches Will Keep Happening

New Open Source App Vulnerabilities

The General Data Protection Regulation Takes Effect

Organizational Doxing

Differential Privacy

Data Retention Policies

Encryption Management

The AI Cloud

More Consolidation in AI

China's AI Boom

2018 TECH TRENDS

NINTH YEAR ON THE LIST

ARTIFICIAL INTELLIGENCE: THE THIRD ERA OF COMPUTING

001-027

AI is "one of the most important things that humanity is working on. It's more profound than, I don't know, electricity or fire."
– *Google CEO Sundar Pichai*

Key Insight

Artificial Intelligence isn't a trend itself. Marvin Minsky, a pioneer in artificial intelligence, often described AI as a "suitcase term." It's a concept that appears simple enough but is actually endlessly complex and packed – like a suitcase – with lots of other ideas, concepts, processes and problems.

Many facets of artificial intelligence (AI) have made our list since we first started publishing this report 11 years ago. AI itself isn't the trend–it is too broad and important to monitor without distinguishing between signals. For that reason, we have identified different themes within AI that you should be following.

Misplaced Optimism and Fear

When it comes to AI, many organizations and their leaders have developed a misplaced sense of optimism or fear. (And sometimes a combination of both.)

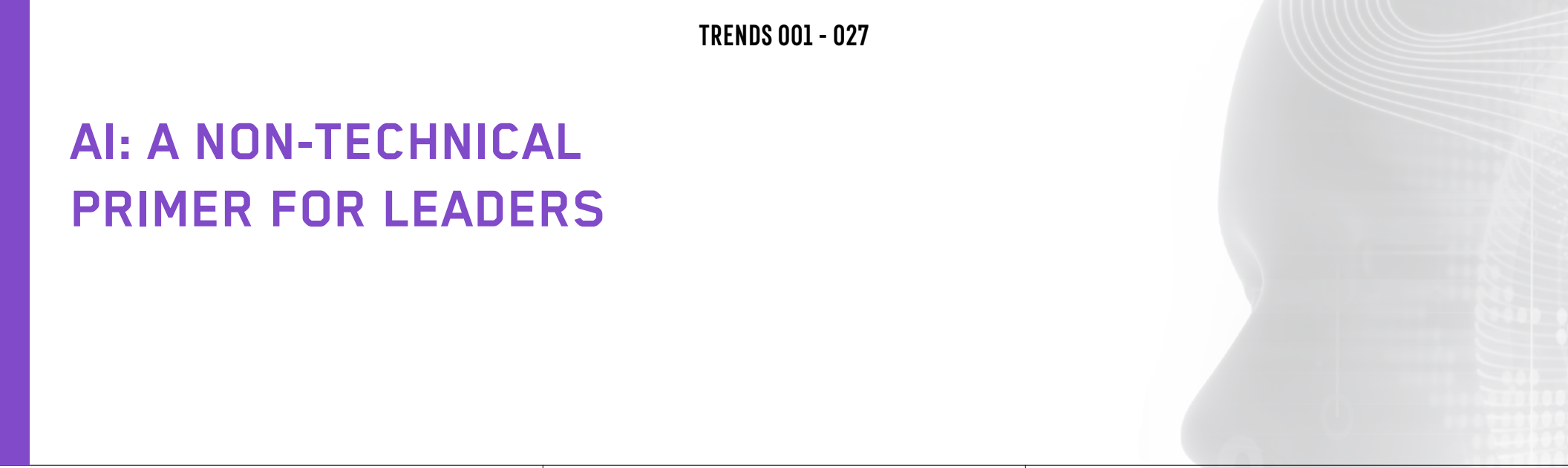
It seems like not a day goes by without a new headline promising that AI will cure all that ails us, or that it will take our jobs, or that it just might kill us all. The real future of AI does promise excitement, but probably not quite how you've imagined.

WE ARE ALL "GEN-T," THE TRANSITION GENERATION:

Everyone alive today is part of Gen-T, the transition generation that will bridge the programmable systems era of computing into the cognitive era, where machines capable of learning, deciding, and creating will co-exist with us.

Though it doesn't feel like it, our generation is living through a great period of rapid transition from conventional computing to artificially intelligent systems. This moment in time is akin to the few decades when the steam engine gave rise to the Industrial Revolution, and Edison and Westinghouse brought electricity into our homes, offices, schools and factories. AI is the new electricity, and our personal data is what's generating the current.

AI: A NON-TECHNICAL PRIMER FOR LEADERS



What You Need To Know About AI

Simply put, AI is a branch of computer science in which computers are programmed to do things that normally require human intelligence. This includes learning, reasoning, problem-solving, understanding language and perceiving a situation or environment. AI is an extremely large, broad field, which uses its own computer languages and even special kinds of computer networks which are modeled from our human brains.

The Short Story of AI's Very Long History

The idea that we might someday create artificially intelligent, sentient robots was first suggested by prominent philosophers in the mid-1600s. Mathematician Ada Lovelace, in the footnotes of a paper she was translating, posited the theory that someday a computer might be capable of creative acts–and to think, just like we humans do. Between the 1930s – 1940s, mathematicians including Alan Turing, Warren McCulloch and Water Pitts published papers that conceptualized neural networks, while Vannevar Bush published a short story called "As We May Think" that envisioned intelligent machines assisting humans. In the 1950s, Turing published another paper, which later became known as the Turing Test, while Claude Shannon published research analyzing how computers might be programmed to play chess. Computer scientist Grace Hopper pushed that idea forward, pioneering early programming languages that were similar to spoken English.

In 1956, researchers met at Dartmouth, for what turned out to be a historic meeting – and the place where the term "artificial intelligence" was first coined by John McCarthy. In the 1950s – 1970s, the field exploded. Margaret Masterman and her team at Cambridge designed the first semantic networks. Jane Robinson established the Natural Language Processing group at SRI, while Barbara Groz figured out that the field would have to pivot eventually and take a different approach.

Researchers had been working towards a functional AI, using the human brain for inspiration, but they didn't have access to enough compute power, data or people trained to advance the field. As a result, the field entered what's known as the "AI

winter," when funding and enthusiasm dried up – temporarily.

In the past decade, new advances by **Alphabet**, **Amazon**, **Microsoft**, **IBM**, **Facebook**, **Apple** – and **Tencent**, **Baidu** and **Alibaba** in **China** – have reignited excitement and funding.

Artificial Intelligence Is The Third Era of Computing

The best way to think of AI isn't as a particular tool, software application or spoken interface. AI represents the next era of computing, after the tabulating era (very early computers) and the programmable systems era.

There Are Different Categories Of AI

There are two kinds of AI–weak (or "narrow") and strong (or "general"). The anti-lock breaks in your car, the spam filter and autocomplete functions in your email, and the recommendations that **Amazon** and **Spotify** make are all examples of artificial narrow intelligence. Maeve and Dolores in Westworld, the Samantha operating system in Her, and the H.A.L. supercomputer from 2001: A Space Odyssey are anthropomorphized representations of artificial general intelligence (AGI)–but actual AGI doesn't necessarily require humanlike appearances or voices. Systems capable of general decision-making and automation outside of narrow specialties (DeepMind beating a world champion Go master) is AGI.

AI, Neural Networks and Deep Neural Networks

A neural network is the place where information is sent and received, and a program is the set of meticulous, step-by-step instructions that tell a system precisely what to do so that it will accomplish a specific task. How you want the computer to get from start to finish–essentially, a set of rules–is the "algorithm."

A deep neural network is one that has many hidden layers. There's no set number of layers required to make a network "deep." Deep neural networks tend to work better and are more powerful than traditional neural networks (which can be recurrent or feedforward).

AI, Machine Learning and Deep Learning

Machine learning programs run on neural networks and analyze data in order to help computers find new things without being explicitly programmed where to look. Within the field of AI, machine learning is useful because it can help computers to predict and make real-time decisions without human intervention.

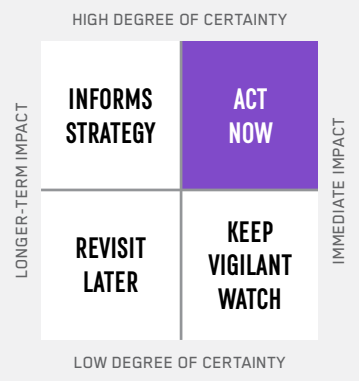
Deep learning is a relatively new branch of machine learning. Programmers use special deep learning algorithms alongside a corpus of data–typically many terabytes of text, images, videos, speech and the like. Often, these systems are trained to learn on their own. In practical terms, this means that more and more human processes will be automated. Including the writing of software, which computers will soon start to do themselves.

When it comes to artificial intelligence, we have a lot of misplaced optimism and fear. The real future of AI doesn't necessarily reflect what we've seen in movies and read in books.

– Amy Webb, Founder of the Future Today Institute

FOURTH YEAR ON THE LIST

AI TRENDS IN THE ENTERPRISE



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001

The AI Cloud

In the past year, the corporate leaders of the AI ecosystem have been racing to capture AI cloud-share–and to become the trusted provider of AI on remote servers. **Amazon Web Services**, **Microsoft's Azure**, **IBM** and **Alphabet** are all rolling out new offerings and packages for developers, hoping to make it easier and more affordable for a wide swath of AI startups to launch their ideas into the marketplace. This isn't just about hosting. Each company now offers off-the-shelf AI software. Amazon's **SageMaker** lets developers train their own neural nets, while **Rekognition** detects and tracks people, activities and objects in video. Microsoft's Azure platform includes both a machine learning studio, to help developers build and deploy solutions–and a toolkit for AI to run locally on connected devices.

002

Proprietary, Homegrown AI Languages

As we enter the third era of computing, the largest companies are starting to compete for both marketshare and mindshare. Companies such as **Microsoft**, **IBM**, **Amazon** and **Alphabet** are releasing software packages for developers–as well as unique programming languages for AI applications. **Uber** released its own probabilistic programming language, Pyro, which it wrote in Python. It's a move that signals likely fragmentation in the future of the AI ecosystem, not unlike our **OSX** vs **Android**, and earlier Mac vs PC camps.

003

AI Chipsets

The standard CPUs found in our desktops, laptops, tablets and mobile phones have certainly gotten powerful–but they're not really designed to meet the demands of machine learning. The problem with our current CPUs is that they don't have enough processing units to make all the connections and computations required in the next era of computing. Enter a suite of new processors found on an SoC–"system on a chip." **Huawei**, **Apple**, **Alphabet**, **IBM**, **NVIDIA**, **Intel** and **Qualcomm** are all working new systems architecture and SoCs, and some come pre-trained. In short, this means that the chips are ready to work on AI projects and should promise better speeds and more secure data. Late in 2017, **Elon Musk** told developers that **Tesla** is also working on its own custom AI hardware chips. Alphabet's chip is called a **Tensor Processing Unit** (or TPU), and was specifically built for the deep learning branch of AI. It is designed to work with the company's **TensorFlow** system. For reference, TPUs are what was used in the famous AlphaGo match between the **DeepMind** system and a world Go champion.

While marketing pre-trained chips to businesses will speed up commercialization and as a result will further R&D, the challenge, of course, is that developers might need to wrestle with different frameworks in the near-future, especially if the various

device manufacturers all decide to start creating unique protocols. We anticipate an eventual convergence, pitting just a few companies–and their SoCs and languages–against each other.

004

Cognitive Computing

This trend has evolved from a key idea in our 2010 trend report: anticipatory computing. Cognitive computing systems use natural language processing and artificial intelligence in order to understand our intentions. **IBM's Watson** platform is a system that uses natural language processing and machine learning to enable people and machines to interact more naturally. Cognitive systems like Watson super-charge our human ability to think through complex problems. On the horizon are cognitive systems built to assist knowledge workers with their thinking tasks in law firms, hospitals, banks and beyond.

005

Bots

You've no doubt heard of a bot: a software application that's been designed to automate certain tasks, such as scheduling or managing basic customer service requests. Bots have now emerged from the fringe and are a fixture in our mainstream vocabulary. During 2018's campaign cycles, we will likely see a resurgence of botnets–networks of computers designed to send out misleading content. We will likely see the intelligence community deploying bots for surveillance and for digital diplomacy. Meantime, more and more customer service functions, to automate meetings or to deal with complaints, will be relegated to bots in the coming year.

006

Marketplaces For AI Algorithms

Most organizations can't staff a team of developers who have unlimited time to create, test and refine algorithms. As a result, communities of developers are offering up their algorithms in emerging algorithm marketplaces. **Algorithmia is like Amazon** but for algorithms, where developers can upload their work to the cloud and receive payment when others pay to access it. **DataXu** offers a marketplace for its proprietary algorithms. **Quantiacs** allows developers to build algorithmic trading systems, and it matches their algorithms with capital from institutional investors. **PrecisionHawk** has launched a marketplace for predictive agriculture algos. A number of other networks, such as **Nara Logics**, **MetaMind**, **Clarifai** offer tools for developers to build deep learning into any application. Look for even more niche marketplaces in 2018.

007

More Consolidation in AI

Some in the AI ecosystem now worry that the future of AI is already under the direction of too few companies. Just nine big companies dominate the AI landscape: **Alphabet**, **Amazon**, **Microsoft**, **IBM**, **Facebook** and **Apple** in the US, along with Chinese behemoths **Tencent**, **Baidu** and **Alibaba** (with significant fortification and support from the **Chinese** government). On the investment side, **Intel Capital**, **Google Ventures**, **GE Ventures**, **Samsung Ventures**, **Tencent** and **In-Q-Tel** lead. As with any technology, when just a few companies dominate the field, they tend to monopolize both talent and intellectual property. They're also partnering to build on each others' work. When it comes to the future of AI, we should ask whether consolidation makes sense for the greater good, and whether competition–and therefore access–will eventually be hindered as we've seen in other fields such as telecommunications and cable.

AI CONT.

AI TRENDS IN CONSUMER-FACING PRODUCTS AND APPLICATIONS

008

Consumer-Grade AI Applications Debut

We're now seeing a shift in highly technical AI applications that professional researchers use to more lightweight, user-friendly apps for less-specialized developers. New automated machine learning platforms, such as **DataRobot**, makes it possible for non-experts to build and deploy predictive models. Many hope that in the near-future, we'll use various AI applications as part of our everyday work, just as we do Microsoft Office or Google Docs today.

009

Digital Assistants Become Ubiquitous

Digital Assistants (DAs)–like **Amazon's Alexa**, **Google Now**, **Apple's Siri** and **Microsoft's Cortana**–use semantic and natural language processing, along with our data, in order to anticipate what we want or need to do next, sometimes before we even know to ask. DAs will become more pervasive in 2018, as device prices fall (look for entry-level speakers that cost less than $20) and as systems get better at interacting with us. Watch for new collaborations between device manufacturers and DA platforms–you'll be able to speak to Alexa in your car and on your morning jog, while Cortana might soon be accessible during work meetings and at your desk. You'll also start to notice DAs hidden throughout other connected devices, such as your home thermostat, your refrigerator and your phone. Researchers at **MIT**, **Stanford**, and the **University of Texas at Austin** are building infrastructure so that our devices will be able to listen and watch: They'll know the places we go, the people we interact with, our habits, our tastes and preferences, and more. Then they'll use this data to anticipate our needs. Marketers, credit card companies, banks, local government agencies (police, highway administration), political campaigns and many others can harness DAs to both surface and deliver critical information.

010

A Bigger Role For Ambient Interfaces

Also known as "zero-UIs," our modern interfaces are becoming more and more like ambient music–able to do more for us with fewer direct actions, yet still able to captivate our attention. Digital Assistants figuratively and literally automatically deliver you the information you need to know, just as you need to know it. Rather than relying on a single input screen, or even a series of screens, we'll instead interact with computers with less friction. In our modern age of information, the average adult now makes more than 20,000 decisions a day–some big, like whether or not to invest in the stock market, and some small, like whether to glance at your mobile phone when you see the screen light up. New DAs promise to prioritize those decisions, delegate them on our behalf, and even to autonomously answer for us, depending on the circumstance. Much of this invisible decision-making will happen without your direct supervision or input. What makes ambient design so tantalizing is that it should require us to make fewer and fewer decisions in the near-future. Think of it as a sort of autocomplete for intention. We will interact both actively and passively with our DAs, found in our hearables, thermostats, cars and pockets. They will listen and observe in the background, sometimes asking questions–other times offering up text, audio or haptic notifications as needed, and those will be decided by algorithm. The real promise of ambient interfaces is explained by **Metcalfe's Law**, which says that the value of a network is the square of the total number of people using it. As more people become part of ambient networks of information, the more use cases we'll see in the future.

011

Deep Linking Everywhere

Deep mobile linking has been around since the beginning of smartphones, and it makes it easier to find and share data across all of the apps in your phone. There are three kinds of deep links: traditional, deferred and contextual. Traditional deep links reroute you from one app or site (such as a link posted in **Twitter**) directly to the app, as long as you have that app installed. Deferred deep links either link straight to content if the app is installed, or to an app store for you to download the app first. Contextual deep links offer much more robust information–they take you from site to app, app to site, or app to app, and they can also offer personalized information. For example, when you land at the airport, you might find that your airline app sends you a link to **Uber**. With advancements in machine learning, app-to-app experiences that are tailored to the habits of individual users should become more ubiquitous.

AI CONT.

AI TRENDS IN SOCIETY AND GEOPOLITICS

012

Making AI Explain Itself

You've undoubtedly heard someone argue that AI is becoming a "black box"—that even those researchers working in the field don't understand how our newest systems work. That's not entirely true, however there is growing concern voiced by computer and cognitive scientists, journalists and legal scholars who argue that AI systems shouldn't be so secretive. Going forward, systems should be able to explain their decisions, offer more transparency and be accountable to those whose data is being used. One big challenge is that offering such transparency could reveal the highly lucrative secret sauce of commercial products. Another challenge: asking the systems to simultaneously explain their decision-making process could degrade the speed and quality of output. Imagine sitting beside a genius mathematician who gives you correct answers—and then asking her to stop and show her work, over and over again.

013

Accountability and Trust

We will soon reach a point when we will no longer be able to tell if a data set has been tampered with, either intentionally or accidentally. AI systems rely on our trust. If we no longer trust the outcome, decades of research and technological advancement will be for naught. Leaders in every sector—government, business, the nonprofit world and so on—must have confidence in the data and algorithms used. Building trust and accountability is a matter of showing the work performed. This is a complicated process, as understandably corporations, government offices, law enforcement agencies and other organizations want to keep data private. Committing to transparency in method would create trust without necessarily divulging any personal data used. In addition, hiring an ethicist to work directly with managers and developers, as well as greatly diversifying the pool of developers to include people of different races, ethnicities and genders will solve for inherent bias in AI systems.

014

Hidden Bias Leads To Big Problems

Every single day, you are creating unimaginable amounts of data, both actively (uploading and tagging photos on **Facebook**) and passively (searching online for medical symptoms, driving to work). That data is mined and used, often without your direct knowledge or understanding, by algorithms. It is used to create advertising, to help potential employers predict our behaviors, to determine our mortgage rates and even to help law enforcement predict whether or not we're likely to commit a crime. Researchers at a number of universities—including the **University of Maryland**, **Columbia University**, **Carnegie Mellon**, **MIT**, **Princeton**, **University of California-Berkeley**, **International Computer Science Institute**, among others—have started to discover unintended, but explicit bias in algorithms. Part of the problem has to do with the building blocks of AI: computers are trained using a limited initial set of data, and the training programs are built by humans. Often, the training sets reveal unacknowledged bias hidden within us. As our computer systems become more adapt at making decisions, we may find ourselves sorted by algorithms into groups that don't make any obvious sense to us—but which could have massive repercussions. You, or someone you know, could wind up on the wrong side of the algorithm and discover you're ineligible for a loan, or a particular medication, or the ability to rent an apartment, for reasons which aren't transparent or easy to understand.

015

China's AI Boom

The development of AI is our modern version of an arms race, and in 2018, China will lay the groundwork to become the world's unchallenged AI hegemon. Here in the U.S., the **Trump Administration** isn't budging on funding increases for basic research, and the Administration is making it more difficult for gifted AI researchers to study, train and develop their ideas in the U.S. But China hasn't exactly hidden its desire to become the global leader in AI. Its government published a three-year plan detailing massive investments from its sovereign wealth fund into AI, establishing a national AI research center, seeking innovations in military applications, formalizing its existing partnerships with leading corporations and research institutions, and doubling-down on educating its citizens. It plans to create a $150bn industry by the year 2030. While China has failed in the past to use industrial policy to dominate a particular sector, it's hard to overlook the facts as we know them in 2018. Three of the most important, and well-capitalized corporations working on the future of AI—**Baidu**, **Alibaba** and **Tencent**—are based in China. China also owns a staggering number of AI patents, while its academics published more research than all of the academics hailing from all of the EU countries combined. China is also a primary investor in U.S. and European AI startups. It isn't just looking for a typical return on investment—Chinese firms expect IP as well.

If data is the new oil, China's massive, 730m online population makes it the owner of the largest natural resource going forward—human data—meaning that it not only has the largest supply of raw materials to use for experimentation and R&D, but it also lacks the privacy and security restrictions that might hinder progress in other nations.

AI CONT.

AI TRENDS IN PROCESSES, SYSTEMS AND COMPUTATIONAL NEUROSCIENCE

016

Real-Time Machine Learning

Machine learning describes a system that uses algorithms to analyze big data sets in order to perform a wide array of tasks better than we can. Over time, the system gets better at those tasks. It learns, even though we might not describe it as "intelligent." One challenge for machines has always been efficiency, since until recently systems had to stop, pull and parse data. New research into real-time machine learning shows that it's possible to use a continual flow of transactional data and adjust models in real-time. This signals a big change in how data moves, and in how we retrieve information. For example, real-time machine learning makes it possible to translate speech automatically, even as multiple languages are spoken. It can be used to improve classification and predictions, promising better-personalized health monitoring and more accurate risk calculations. Consumers can expect more customized recommendations from retailers—especially if their tastes and preferences tend to shift along with the seasons. Rather than using historic data alone (Customer #1234 only likes red lipstick), real-time preferences would add context to the recommendation (Customer #1234 might purchase red lipstick only in the next three weeks).

017

Natural Language Understanding (NLU)

We are surrounded by unstructured text in the real world—it exists in our social media posts, our blog entries, on company websites, within city hall digital records, and elsewhere. NLU allows researchers to quantify and learn from all of that text by extracting concepts, mapping relationships and analyzing emotion. NLU will augment the work of professional researchers—those working in science and medicine, law and policy, infrastructure, agriculture, transportation, education and beyond—allowing them to glean deeper insights than ever before.

018

Machine Reading Comprehension (MRC)

For AI researchers, machine reading comprehension has been a challenging goal, but an important one. MRC makes it possible for systems to read, infer meaning, and immediately deliver answers while sifting through enormous data sets. One practical application on the consumer side: if you perform a search query, wouldn't you rather have a system offer you a precise answer than just a list of URLs where you can go to hunt down more specifics—even showing you where, on the page, that information comes from? If you are an airline mechanic and you're trying to troubleshoot a tricky engine problem without further delaying a flight, it would be easier if you had a computer read all of the technical documentation for you and suggest likely fixes. Or, better yet, let the machines figure out what's wrong on their own, by making all technical manuals and documentation available to them for reading and analysis. That's the promise of MRC. MRC isn't focused on keywords alone. In the future, a trained MRC system could be transferred to different domains where no human has created labels or even a standard taxonomy. MRC is a necessary step in realizing artificial general intelligence, but in the near-term it could potentially turn everything from technical manuals to historical maps to our medical records into easily searchable repositories of information.

019

Natural Language Generation (NLG)

Algorithms can rewrite structured data into a narrative using natural language generation. Dozens of news and other organizations, including **Bloomberg** and the **Associated Press**, have been using **Automated Insights**, which mines data and is capable of writing more than 2,000 stories per second using natural language generation to produce stories about fantasy football, earnings reports and the like. **Narrative Science** employs its NLG system to build narratives out of big data sets and to help non-data science people make better sense of what's happening within their organizations. NLG will have myriad use cases across professional fields, assisting lawyers, politicians, doctors, consultants, financial analysts, marketers and beyond, who will soon incorporate our personal information as data points for narratives.

020

Generative Algorithms For Voice, Sound and Video

Researchers at **MIT's CSAIL** are studying how children learn new words in order to train computers on automatic speech recognition. As humans, we are able to master a new concept from just one or

AI CONT.

two examples; for machines, this is a more difficult task when it comes to language. Meanwhile, researchers are training computers to watch videos and predict corresponding sounds in our physical world. For example, what sound is generated when a wooden drumstick taps a couch? A pile of leaves? A glass windowpane? The focus of this research is to help systems understand how objects interact with each other in the physical realm. But future versions of the algorithms could be used to automatically produce sound and sound effects for games, videos, movies and TV shows. It also raises the specter of audio fraud–what happens when computers are able to spoof our voices and natural sound? There have already been a few early successes: in 2017, researchers at the **University of Washington** developed a model that convincingly showed **President Barack Obama** giving a speech–that he never actually gave in real life.

021

Image Completion

If a computer system has access to enough images–millions and millions–it can patch and fill in holes in pictures. There are practical applications for professional photographers as well as everyone who wants to take a better selfie Soon, if the foreground of a mountain is out of focus, or if your skin has an unsightly blemish, another version can be swapped in to generate the perfect picture. But what of the next-order scenarios and implications? How will we draw the line between reality and enhancement? How much image completion should be allowed without tacking on a warning label or disclosure? Online daters, journalists, and marketers should be asking these questions. But so should policymakers. Image completion is also a useful tool for law enforcement and military intelligence officers–computers can now assist them in identifying who or what is in the frame. Given the bias we've already seen across machine learning algorithms and data sets, image completion could become part of a future debate about privacy and our devices.

022

Predictive Machine Vision

Researchers at **MIT's CSAIL** have trained computers to not only recognize what's in a video, but to predict what humans will do next. Trained on **YouTube** videos and TV shows such as "The Office" and "Desperate Housewives," a computer system can now predict whether two people are likely to hug, kiss, shake hands or slap a high five. This research will someday enable robots to more easily navigate human environments–and to interact with us humans by taking cues from our own body language. It could also be used in retail environments, while we're operating machinery, or while we're in classrooms learning.

023

Much Faster Deep Learning

Deep Learning (DL) is a relatively new branch of machine learning, and it will soon be an invisible part of every organization. Programmers use special deep learning algorithms alongside a corpus of data–typically many terabytes of text, images, videos, speech and the like. The system is trained to learn on its own. While conceptually, deep learning isn't new, what's changed recently is the amount of compute power and the volume of data that's become available. In practical terms, this means that more and more human processes will be automated, including the writing of software, which computers will soon start to do themselves. DL has been hampered by the processing power of computer networks. Just a few years ago, it would take a month or longer to train an image recognition model on the **ImageNet** dataset. Today, with more advanced equipment, **Facebook** can do the same in under an hour. As computers become faster–and as hardware architecture evolves–our systems will perform tasks at super-human speeds.

024

Reinforcement Learning and Hierarchical RL

Reinforcement Learning (RL) is a powerful tool for sorting out decision-making problems, and it's being used to train AI systems to achieve super-human capabilities. Inside of a computer simulation, a system tries, fails, learns, experiments and then tries again–in rapid succession, altering its future attempts each time. It's because of RL that **AlphaGo**, a computer developed by **DeepMind** (part of **Alphabet**) learned how to beat the greatest Go players in the world. One problem with RL: agents have difficulty when they don't have enough supervision, or when they're objective is to run scenarios for a very long time horizon. In 2018 and beyond, researchers will try to solve those problems using **Hierarchical Reinforcement Learning**–that discovers high-level actions and work through learning challenges methodically, in order to master new tasks at speeds we humans can't imagine. This is important for non-techies, too: RL will improve the "intelligence" in our AI systems, helping cars learn to drive in unusual conditions and helping military drones perform complicated maneuvers that have never been attempted before in the physical world.

025

Continuous Learning

At the moment, deep learning techniques have helped systems learn to solve complex tasks that more closely matches what humans can do–but

Researchers are now training systems to learn more like Daniel from *The Karate Kid.*

those tasks are still specific, such as beating a human at a game. And they require a rigid sequence: gather data, determine the goal, deploy an algorithm. This process requires humans and can be time-consuming, especially during early phases when supervised training is required. Continuous Learning (CL) is more about autonomous and incremental skill building and development, and researchers will continue pushing the limits of what's possible in 2018.

026

Multitask Learning

If you watched the original *Karate Kid* movie, you'll remember Mr. Miyagi promising to teach Daniel karate–and Daniel getting frustrated with days of painting fences, sanding floors and "wax on, wax off." To Daniel, none of these activities seemed related, and they certainly didn't appear to help him with his stated objective: to learn karate. Of course, it turns out that all of these chores were indeed connected, and Daniel's repetitive learning is what helped him become a formidable karate champion. Researchers are now training systems to learn like Daniel. When developers use Machine Learning, they are doing so to try and solve for a particular task or problem. They supervise the system, fine-tuning it and making adjustments until the models perform as desired. But focusing only on a single task often leads to inefficiencies–perhaps there's a better solution to the problem than the method developed by the researcher. A new area of research–multitask learning–helps systems learn more like Daniel, exploiting the relationships between various, related tasks in order to solve problems better.

027

Adversarial Machine Learning

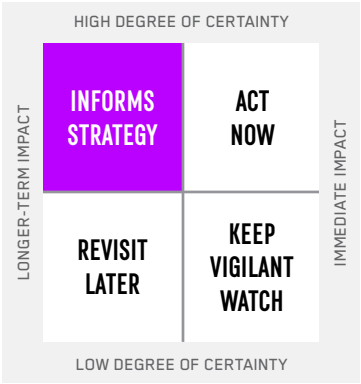
In short, an adversarial piece of content–a photo, a video, an audio file–is encoded with a tiny modification, usually one that's imperceptible to humans. It's created in order to help computer scientists adjust machine learning models. Hackers use adversarial examples in a machine learning system to attack it, causing the model to make a mistake. In order for machine learning systems to *learn*, they must recognize subtle differences. Researchers also use adversarial information to train systems how to recognize misleading information in order to secure it. Adversarial information is sort of like an optical illusion and it's typically imperceptible to the human eye or ear. It could be one pixel out of a million that's the wrong color or is misaligned–to you, all those pixels together might still look like a photo of a rainbow, but to a machine learning model, that one out-of-place pixel could render the image gibberish. When that happens, an adjustment is made to the system and it continues training. Adversarial images can be used to knowingly and purposely trick a machine learning system. If an attacker trains a model, using very slightly altered images, the adversarial examples could then be deployed out into other models. Adversarial examples can be embedded–intentionally, or by accident–into photos, multimedia stories, virtual reality content and the like. This is important to keep in mind, especially as fake news continues to proliferate in digital channels. It's especially perplexing for search engines (**Google**, **Bing**) and for any service that automatically tags our photos (law enforcement databases, **Facebook**).

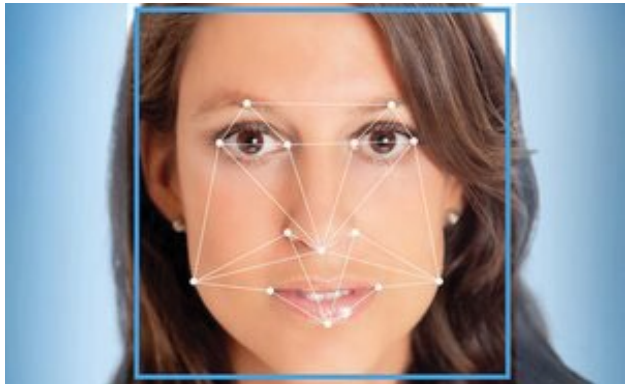
RECOGNITION TECHNOLOGIES

SECOND YEAR ON THE LIST

Faceprints

028





Google challenged the Illinois Biometric Information Privacy Act in court in 2016.

Key Insight

Advanced computing systems can now use unique features of our faces–our bone structure, skin color, even capillaries –to identify us. Faceprints are the new fingerprints.

Examples

Faceprints are a newer form of biometric authentication. In 2014, Facebook announced its "**DeepFace**" software, which was capable of recognizing the people in photos with 97% accuracy (that's about the same accuracy as humans). **Saks Fifth Avenue** is one example of a luxury store that's now using faceprints to track VIP customers. Last year, **Apple** introduced its **Face ID system** with the **iPhone X**. It unlocks the phone using infrared and visible light scans to identify the unique characteristics of your face. **China's Byton** has built an electric SUV that you unlock with a faceprint, rather than a key fob. Researchers in **Japan** and **China** are working on representation models that require only a portion of your face, even in low light, to accurately predict someone's identity–even as they change their hairstyles, get plastic surgery or grow a beard.

What's Next

German researchers are working to create thermal faceprints by taking heat maps of our faces and using machine vision to recognize patterns. Their technology can accurately identify a face–and in under 35 milliseconds, regardless of the amount of lighting or the facial expressions people make. Researchers at **NEC** in Japan are taking multiple 3D scans to quickly check a person's face against those catalogued in a registry; it's expected to deploy the system for everyone participating in the 2020 Olympics. Chinese startup **Megvii Face++**, supported heavily with sovereign wealth funds from both China and **Russia**, is pioneering faceprint technologies that are secure enough to be used for financial transactions. Face++ is also being used by China's police force for widespread surveillance. Unlike fingerprinting or iris/ retinal scanning, which are difficult to do without someone's direct knowledge, faceprints can be taken surreptitiously, even from far away.

We anticipate legal challenges, at least here in the U.S. Last year, a federal judge allowed a class-action suit brought against **Shutterfly** for allegedly violating the **Illinois Biometric Information Privacy Act**, which requires companies to secure written releases before collecting biometric data, which includes their faces. (This Illinois state law is the only one of its kind in the U.S.)

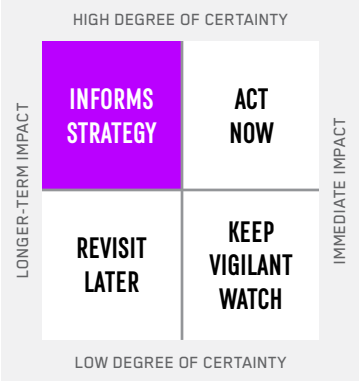
Watchlist

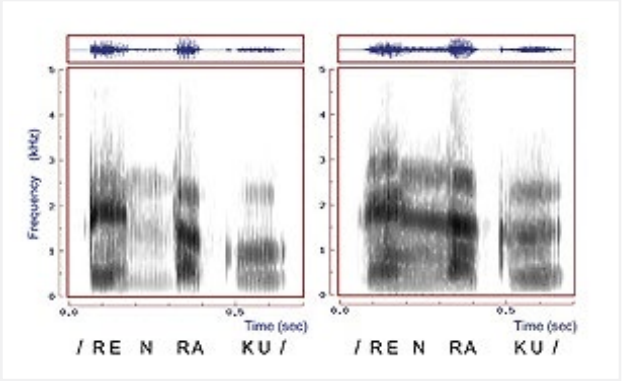
FaceTec; Megvii; CyLab Biometrics Center at Carnegie Mellon University; Noveto; SenseTime; Sensible Vision; China; Russia; Alphabet; LG; Apple; Facebook; Alibaba; Samsung; Android; NEC; U.S. Government Accountability Office.

SECOND YEAR ON THE LIST

Voiceprints

029





These two voiceprints are analysis results from saying, "REN-RAKU", over the telephone. The voices are from two different speakers.

Key Insight

Technology has made it possible to recognize who you are, even without seeing your face.

Examples

Voiceprints are the set of unique characteristics that make up your individual voice. New machine learning techniques, combined with vast datasets of recorded voices, have now enabled researchers to identify us simply by listening for the microsignatures produced when we speak. San Diego-based KnuEdge built a military-grade platform capable of recognizing our individual voices, even in a noisy environment. Founded by **NASA's** former Chief Administrator and its Chief Technology Officer, KnuEdge hired world-class voice impersonators to see if they could fool the system, but the technology prevailed every time.

What's Next

Nuance Communications is working with auto manufacturers, including **Ford** and **BMW**, to develop more accurate voice recognition in the cockpit. Theoretically, this same technology could be used to detect whether a driver has had too much to drink or is suffering from a health condition, making it unsafe to operate the vehicle. Voiceprints could be used to unlock the door when your arms are full of packages—and to help digital assistants, such as **Alexa**, customize interactions for each member of your family. Researchers at **Carnegie Mellon University** discovered a generative technique allowing them to build a 3D version of someone's face using only their voiceprint. This system is being deployed by law enforcement agencies to identify prank callers and those who trick local agencies into sending out swat teams to take out retaliation or revenge on others.

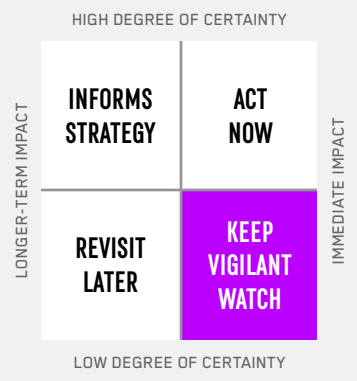
Watchlist

KnuEdge; MIT Media Lab; Amazon; Microsoft; DARPA; Alphabet; Nuance Communications; Apple; IBM; Carnegie Mellon University; Alibaba; Tencent; Samsung.

SECOND YEAR ON THE LIST

WiFi Tracking

030



WiFi transmitters in homes and offices will be able to track your movements soon.

Key Insight

WiFi and radio waves can now be used to track our physical movements and our emotional states.

Examples

The WiFi transmitter in your home or office is continually sending and receiving information, which it converts into radio waves. The signals aren't very strong, only filling up the space around you (and possibly just outside to the street). It turns out that with the right device, it's possible to watch us walking through the signals as they bounce off us and onto other objects. What this means in practice: WiFi signals can be harnessed to recognize us through our walls.

What's Next

Researchers at **MIT** and **Massachusetts General Hospital** developed a device that uses an advanced AI algorithm to analyze the radio signals around someone when they're sleeping. The system then translates all of their body movements into the stages of sleep: light, deep or REM (rapid eye movement). Imagine a future in which your WiFi router collects your physical movements, then calculates your health metrics, and automatically adjusts the devices and appliances in your house to help you live a better life? For example, if you're snoring, your pillow could automatically inflate or deflate.

They're also using WiFi to detect your emotional state. **EQ-Radio** can read your emotions using a wireless router. In testing, EQ-Radio successfully detected emotions without disturbing the person being monitored.

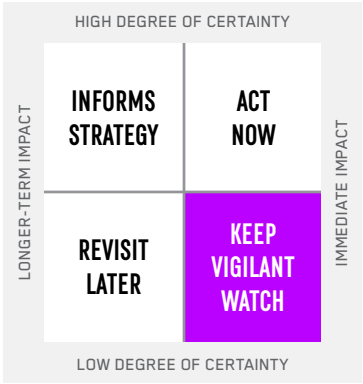
Watchlist

MIT; Massachusetts General Hospital.

Imagine a future in which your WiFi router collects your physical movements, then calculates your health metrics, and automatically adjusts the devices and appliances in your house to help you live a better life.

FIRST YEAR ON THE LIST

Gesture Recognition



The Microsoft Kinect uses NUI for gaming.

031

Key Insight

Gesture recognition technologies are now capable of interpreting motion to identify us and make decisions on our behalf.

Examples

Emerging gesture recognition systems represent Natural User Interfaces (NUIs), and they are an important component for the future of augmented and virtual reality alike. Imagine picking up a digital object with your hand, or controlling a remote robotic arm without being tethered to a bunch of wires. Gesture recognition unlocks the interplay between our physical and digital realms. **Leap Motion** came to market early with a desktop controller that allowed users to control their computers using finger and hand gestures. **Microsoft's Kinect** successfully delivered an NUI for gaming. **DJI's** latest drones can be triggered to fly and to take photos using gestures (and without needing the remote control).

What's Next

In the next few years, we'll see more NUIs that allow us to control machines through our body movement alone. We'll also start to see applications in the workplace that record our body movement to predict when we're most productive. It could also help security learn when we might cause harm to others. Given recent mass shooting tragedies in the U.S., NUIs could be one part of a future solution to curbing violence.

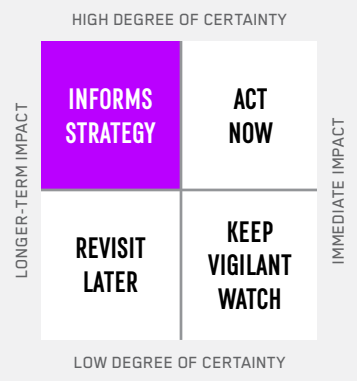
Watchlist

DJI; Leap Motion; Magic Leap; Microsoft; Qualcomm; Intel; Samsung; Sony; Texas Instruments; Thalmic Labs; Softkinetic; eyeSight Technologies; Crunchfish; Infineon Technologies; Freescale Semiconductor; Jabil; PointGrab; Pyreos; Rithmio; Apple.

FOURTH YEAR ON THE LIST

Personality and Character Recognition

032



Cambridge Analytica, claims to have used algorithmic profiling to help Donald Trump win the election.

Key Insight

Emerging predictive analytics tools wrangle your data, behavior and preferences in order to map your personality–and predict how you're likely to react in just about any situation. These tools can be used in journalism, to personalize customer interactions and even to personalize the news itself.

Examples

Political candidates, law firms, marketers, customer service reps and others will begin using new systems that review your online behavior, emails and conversations you have by phone, and in person, to assess your personality in real time. The goal: to predict your specific needs and desires. **Mattersight Corporation** is using personality and behavior to route calls through call centers, and its latest "Predictive Video" system promises to analyze your speech and facial expressions from any video where you've appeared. **Cambridge Analytica**, claims to have used algorithmic profiling to help Donald Trump win the election.

What's Next

Researchers at the **University of Cambridge's Psychometrics Centre** developed an algorithm that predicts personality traits from **Facebook** likes. **ElectronicArts** is working on a system that assesses the personality of its multiplayer video game users to do a better job of matching players, using their play style, conversational style, and willingness to spend money. In the real world, insurance underwriters are attempting to assess your personality–via your magazine and website subscriptions, the photos you post to social media, and more–in order to determine how risky an investment you are. Some lenders have used personality algorithms to predict your future financial transactions. (The data show that if you look at two people with the same professional and personal circumstances, the one with a higher college G.P.A. will be more likely to pay off a debt.) Meanwhile, facial and tonal recognition analytics will help machine learning systems to detect consumers' emotional state in real-time. Algorithms will harness your data in order to assess your predicted success at work, how likely you are to bounce around jobs and more.

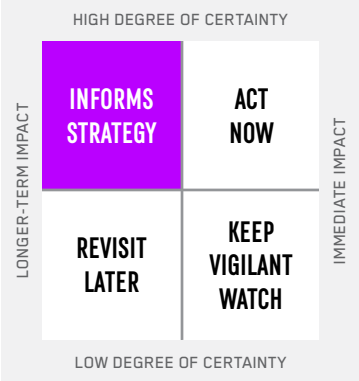
Watchlist

Mattersight Corporation; Cambridge Analytica; Caliper; University of Texas; MIT; IBM; Twitter; Crystal; Stanford University; Salesforce; Autodesk; Symantec; Mobileye; Intuit; Adobe.

FIFTH YEAR ON THE LIST

Ambient Proximity

033



The Guggenheim in New York City uses beacons to help visitors learn about exhibits.

Key Insight

New technologies can be programmed to push or receive information to/ from our devices–and also our bodies–tethering us to an always-on information network.

Examples

In the late 1980s, **Ericsson Mobile** experimented with short-link radio technology, but it would take a decade for mobile service providers to create the industry standard known as **Bluetooth** today. Our current Bluetooth standard was developed for the internet of things–which is why you're hearing so much about beacons, which are tiny devices that broadcast a signal and trigger actions based on proximity. **Target** has outfitted hundreds of its stores with beacons, which track consumers as they move around various parts of the store. **The Guggenheim** uses beacons to help attendees learn about exhibits. Beacons are widely used in infrastructure and public transit systems. Some researchers estimate that 5 million new beacons will be installed around the U.S., for various purposes, during 2018.

What's Next

We are likely to see new consumer applications during 2018 and 2019, as proximity networks become more mature. We anticipate that our personal data, combined with data from everyday items in the physical world, will entice developers to build new uses for ambient proximity in the coming years.

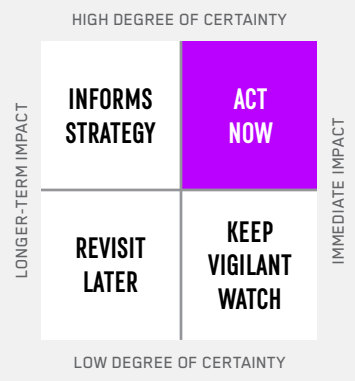
Watchlist

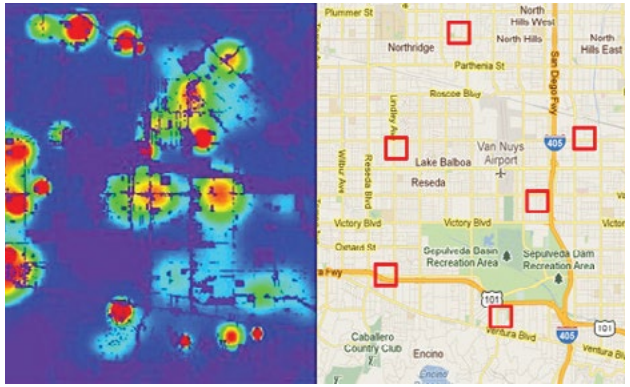
Alphabet's Eddystone; Apple's iBeacon; Estimote; Kontakt.io; Gimbal; BlueCats; Gelo; BLIP Systems; Blue Sense Networks; Glimworm Beacon; Sensorberg GmbH; Accent Advanced Systems; Aruba; Amazon; Qualcomm; PayPay; Polytechnical University (China); MIT; University of New South Wales (Australia); Oxford University; National Emergency Address Database.

FOURTH YEAR ON THE LIST

Hidden Bias in Recognition Technologies

034





PredPol software is one of the systems under scrutiny for embedded bias in its system.

Key Insight

By now, it's no secret that some of our machine learning models—and the data they use to recognize others—are encoded with bias. That's because the people who built the models are themselves subject to unconscious bias, as well as more explicit homogeneous learning and working environments.

Examples

In 2016, **ProPublica.org** published an exceptional investigation on machine bias and the problem of using AI to predict future criminals. Their findings: so-called "risk assessment" software is increasingly common in courtrooms across the nation, and it is used to inform decisions about everything from bond amounts to the length of a criminal sentencing. Perhaps unsurprisingly, the software is biased against black people.

(We encourage you to read ProPublica's full report: https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing).

What's Next

Risk assessment software is hardly an outlier. Numerous studies undertaken by prominent universities, including **MIT**, **Harvard**, **Carnegie Mellon**, **Princeton**, **University of California-Berkeley** (among others) have shown explicit bias in algorithms across many industries and social sectors. Algorithmic bias is a problem that will get worse, especially as more recognition technologies are used in law enforcement and within the justice system. Computers are trained using a limited initial set of data, and the training programs are built by humans. Often, the training sets reveal unacknowledged bias hidden within us.

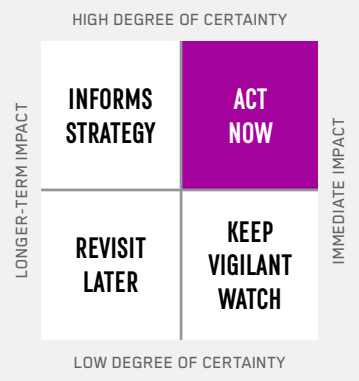
Watchlist

PredPol; Fluidinfo; Omega Group; LexisNexis; Azavea; Motorola; Zuercher; Investigative Reporters & Editors; National Institute for Computer-Assisted Reporting; Coral Project; Stanford Computational Journalism Lab; Duke University; University of British Columbia; University of Texas at Austin; Brown Institute at Columbia University; Tow Center for Digital Journalism at Columbia University; Philip Merrill College of Journalism at the University of Maryland; Media Change and Innovation Division at the University of Zurich; Annenberg School of Communication & Journalism and the University of Southern California; Wall Street Journal; New York Times; Texas Tribune; Washington Post; Tamedia; ProPublica; National Public Radio.

SECURITY, PRIVACY AND DATA

SEVENTH YEAR ON THE LIST

SECURITY



035-054

Key Insight

Expect more sophisticated data breaches, advanced hacker tricks, and targeted ransomware on the devices in your home and offices.

035

Compliance Challenges and Unrealistic Budgets

The historical tension between security and privacy will unleash new challenges in 2018. Consumers are shedding more data each day, and as more connected devices enter the marketplace the volume of available data will balloon. Yet those organizations creating devices and managing consumer data aren't planning future scenarios. Off-the-shelf compliance checklists won't cut it going forward. Managers will need to develop and to continually update their security policies—and they'll need to make the details transparent. Most organizations aren't devoting enough budget to securing their data and devices. Organizations that haven't carved out enough budget for IoT security will find themselves dealing with vast recalls, remediation and lawsuits. We'll see this in action during 2018, as the **General Data Protection Regulation (GDPR)** promises a significant headache for compliance officers and risk managers, who must ensure that the policies and procedures for governments, companies, nonprofits and news organizations are current.

036

DDoS Attacks Will Increase

A Distributed denial of service attack (DDoS) attack happens when a hacker sends so many requests to a battalion of machines that the entire network goes down. In the past several years, the number of DDoS attacks have spiked. The U.S. was hit with 122 million DDoS attacks between April – June 2017 alone. You may remember a massive cyber attack that effectively turned off **America's internet**—it was caused by the **Mirai botnet** and infected **Dyn**, a company that controls a large portion of the internet domain name system infrastructure. To date, half of the world's attacks have originated in **China**. Hackers are using more sophisticated tools, which means that future attacks will be larger in scope and could achieve greater impact.

037

Ransomware As A Service

We saw the spread of ransomware—**WannaCry**, **Petya**, **NotPetya**—during 2017. In **England**, WannaCry shut down the computers in 80 medical centers, which resulted in hospitals diverting ambulances and 20,000 cancelled appointments. Hackers deploy malicious tools to hijack data, effectively locking out systems and devices, until a fee is paid. Since cash and online bank transfers are easy to track, the currency of choice is now bitcoin, which moves through an encrypted system and can't be traced. The emergence of the blockchain and cryptocurrencies have transformed ransomware into a lucrative business. Simply backing up your data probably won't be enough of a failsafe going forward.

The WannaCry ransomware attack locked thousands of computers.

Researchers have already found "doxware" floating around the internet—rather than simply holding your data hostage until you pay up, they threaten to publish it all to the web, for everyone to see.

038

Russia's Gifted Hacker Community Grows

Russia is home to the world's most gifted and prolific hackers, who are motivated both by a lack of economic opportunity and weak law enforcement. While people with the same skills sets could make six-figure salaries in the West, they struggle to get by, receiving only a few hundred dollars a month from Russian employers. Over time, this has created a perfect storm: enormously talented people, weak laws and poor economic conditions have led to a growing pool of talented hackers. In the past two years, it's become clear that Russia's military and government intelligence agencies are eager to put home-grown hackers to work, infiltrating the **Democratic National Committee**, **Olympic organizations** and **European election commissions**.

039

New Infrastructure Targets

In 2018, cybercriminals will target critical infrastructure and facilities around the world. For many years, security experts have been warning that hackers would be able to disable dams, power plants and traffic lights, and now it seems as though our day of reckoning is here. Late in 2017, security firm **FireEye** discovered a new form of malware called **Triton**, which had taken control of an energy plant in the **Middle East**. In a separate attack, hackers attacked **Ukraine's** power grid using malware called **Industroyer**. Cybersecurity company **Symantec** has warned that hackers have already penetrated the **U.S. power grid**, targeting staff at nuclear energy facilities with phishing attacks. The **U.S. Computer Emergency Readiness Team** issued a sternly-worded notice, but with no enforcement mechanism it's clear that the companies and utilities managing our critical infrastructure haven't yet been jolted into action.

040

Hacktivism On The Rise

Hackers-turned-activists have had a busy few years, working for causes they believe in. They launched DDoS attacks against governments, corporations and banks. They infiltrated the campaigns of both **Hillary Clinton** and **Donald Trump**. Hacktivist organizations, including **Anonymous**, **WikiLeaks** and **DC Leaks**, see themselves as durable forces of change. Glamourized by the TV show Mr. Robot, hacktivism is on the rise, and given heated political tensions during a year in which many elections are being held, we'll likely see more operations being carried out. Hacktivists will use their skills to help shape local, state, national and international politics, conversations and business practices.

SECURITY CONT.

041

Third-Party Verified Identities

In the U.S., citizens must continually hand over their social security numbers for authentication. But in the wake of last year's massive **Equifax data breach**, it has become clear that our social security numbers–a single identifier used in everything from our bank accounts, to our health insurance, even the university registrar–isn't secure. Social security numbers were never intended to be used as general-purpose passwords. We will start to see the emergence of third-party, non-governmental providers of verified identities. One example that's already in the marketplace is **CLEAR**, the trusted traveler program that lets verified customers get through airport security faster.

042

Targeted Attacks on Digital Assistants

Now that digital assistants (DAs)–**Alexa**, **Siri**, **Cortana**, **Google**–have moved from the fringe to the mainstream, we can expect to see targeted attacks. Whether they target the assistants or their hardware (**Amazon Echo**, **Apple HomePod**, **Google Home**), it's clear that the next frontier in hacking are DAs.

043

Zero-Knowledge Proofs Go Commercial

With all of the hacking scandals that have plagued us in the past several years, we will see a transition to something called "zero-knowledge proofs," which allows one party to verify data without conveying any additional information (like how or why the mathematical statement is true). It's a mind-bending approach to security, allowing you to verify your identity without actually revealing who you actually are. In essence, this eliminates the need for a company to store private identity data during the verification process. Zero-knowledge proofs aren't new, but deploying them to protect our credit cards and online identities is an emerging application. **JP-Morgan Chase** is using zero-knowledge proofs for its enterprise blockchain system, while cryptocurrency startup **Ethereum** are using zero-knowledge for authentication. Irish startup **Sedicii** now has zero-proof software in the marketplace. Researchers at **Microsoft** and **Princeton University** are working on a zero-knowledge proof so that inspectors can identify something such as a nuclear weapon without requiring them to take it apart, which would spread information about how to build one.

044

Zero-Day Exploits On The Rise

A zero-day vulnerability is a flaw–a problem within a hardware or software system that developers didn't discover during the testing process. That vulnerability can be exploited by malware to cause all sorts of problems. Zero-days are dangerous, prized tools and discovering them is a favorite activity of malicious hackers. Once the flaw is revealed, programmers have zero days to do anything about it. There are a number of zero-day exploits that have been lying dormant for years–we learned about two late in 2017. A flaw found on chips made by **Intel** and **ARM** led to the realization that virtually every Intel processor shipped since 1995 was vulnerable to two new attacks called **Spectre** and **Meltdown**. Earlier, the Italian spyware maker **Hacking Team** (HT) helped bring zero-days into the spotlight when it was found selling commercial hacking software to law enforcement agencies in countries all over the world. Data leaked from HT, along with a massive dump of 400 gigabytes of internal emails, revealed a number of zero-day exploits. The HT breach helped to shine a light on a growing zero day marketplace, with some exploits being sold for as much as $500,000. Tools to exploit vulnerabilities will be in greater demand throughout the near future.

045

Backdoors

In the wake of the deadly **San Bernardino** attack in December 2015, the FBI and Apple found themselves debating so-called "**backdoors**" in public. The FBI demanded that Apple unlock the assailant's phone, and Apple refused, arguing that creating a software update to allow a backdoor would endanger the privacy of us all. It's a debate that was never settled–and we'll likely see more cases pitting government agencies against big tech companies in the years to come. While they sound malicious, backdoors aren't necessarily bad. Often, developers intentionally install them into firmware so that manufacturers can safely upgrade our devices and operating systems. The challenge is that backdoors can also be used surreptitiously to harness everything from our webcams to our personal data. Given the rise of zero-day exploits, we should question whether backdoors are the best way forward. Government officials worldwide have been advocating for a set of "**golden keys**," which would allow law enforcement to break through the security using backdoors. But even without public agreement, some agencies may find their way into our machines. In 2013, the **U.S. National Security Agency** made a deal with security company **RSA** to include a flawed algorithm, effectively giving the NSA a backdoor into various systems. The challenge is that the simple act of creating a backdoor would leave ordinary people vulnerable to everyday attacks by a wide swath of actors, benevolent and malicious.

OPTIMISTIC REMOTE KILL SWITCH SCENARIO – SMART ALARMS WILL SAVE LIVES

Amy Webb

During the 2018 power outage at the Consumer Electronics Show, hundreds of attendees were wired in to various digital services—relaxation pods, self-driving cars, virtual reality games. Since a lot of exhibitors at CES were also running battery backups, those wired into some of the simulations had no idea what was going on outside in the real world. As our technologies become more immersive, remote kill switches will become necessary in the near future.

Imagine that you're just getting over a head cold and you're sitting in your bedroom with the door closed, wearing a head mounted display and earphones, fully immersed in a virtual world—when suddenly a fire breaks out in your kitchen. You can't hear the fire alarm, you don't see flames and, because of your stuffy nose, you don't notice the smell of the smoke. In the future, a smart alarm will trigger a remote kill switch in your VR system and help you get out of your house alive.

SECURITY CONT.

046

Remote Kill Switches

As our technology becomes more immersive, we'll have increased needs for remote kill switches. Kill switches, found on smartphones and connected devices, will soon come in handy for the enterprise and for government agencies. **Uber** developed its own software program called **Ripley** that could be activated by staff in San Francisco, should any of its overseas offices be raided by police. It also deployed **uLocker**, a remote kill switch that could lock all company devices, including laptops and phones. On the consumer side, both **Apple** and **Android** now allow users to remotely wipe all the information on their phones and tablets using a web interface. The benefit would come with a cost, however. Kill switches would mean that nobody could gain access to what's inside a lost or stolen phone–not even law enforcement.

047

AI-Powered Automated Hacking

Thanks to advancements in AI, one of the big trends in security is automated hacking–in short, software that's built to out-hack the human hackers. The **Pentagon's** research agency **DARPA** launched a **Cyber Grand Challenge** project in 2016, with a mission to design computer systems capable of beating hackers at their own game. DARPA wanted to show that smarter automated systems can reduce the response time–and develop fixes in system flaws–to just a few seconds. Spotting and fixing critical vulnerabilities is a task that might take a human hacker several months or even years to complete, and yet the machine that won the Grand Challenge proved its might in just a fraction of the time. The winner became the first non-human entity to earn **DEF CON's** black badge, which is the hacking community's equivalent of an Oscar. In 2018, we will see new techniques, advanced learning algorithms and a strange new playing field. Very soon, malicious actors will create autonomous systems capable of automatically learning new environments, exposing vulnerabilities and flaws, and then exploiting them for gain–or whatever the stated objective, which could simply be generalized mayhem.

048

Offensive Government Hacking

In the wake of several hacking attacks during elections around the world, several government agencies are now making public their plans to hack offensively. The **U.K.'s National Health Service** has started hiring white hat (benevolent) hackers to safeguard it against another ransomware attack like **WannaCry**, which took the nation's health care system offline and resulted in diverted ambulances during medical emergencies. **Singapore's Ministry of Defense** is hiring white hat hackers and security experts to look for critical vulnerabilities in its government and infrastructure systems. In the U.S., the two agencies responsible for cyberwarfare–the **U.S. Cyber Command** and the **National Security Agency**–are playing offense, especially as artificial intelligence becomes a focus for U.S. cyber strategy. Both are looking to a future in which artificial intelligence enhances offensive operations and replaces human troops–but in the meantime, there's a shortage of gifted hackers willing to join government ranks. That's due in part to a bad public image in the wake of **Edward Snowden**. However since the U.S. is already facing a severe shortage of cybersecurity workers–upwards of 270,000 jobs are still unfilled–skilled hackers can command lots of perks and big paychecks outside of the government.

049

More Cyber Mission Forces in the Field

In the summer of 2016, the **U.S. military** began deploying its **Cyber Mission Force**. These are units of civilians and military personnel, and they are charged with protecting military networks from cyber intrusions and our national infrastructure. Some of the units also support combat missions. The force became fully operational a year ahead of schedule–but many within the mission argue that to fully realize its potential, a different organizational approach is necessary. The current structure and titles in the military don't mesh with the realities of cybersecurity and how hacker networks operate.

050

Strange Computer Glitches Will Keep Happening

Glitches are problems that don't have an immediate, obvious cause but nonetheless can cause frustrating problems. **Tesla** missed its 2017 Q4 delivery target for its Model 3 due, in part, to technical glitches on the assembly lines. In the past year, **Barclays**, **JPMorgan Chase**, **Bank of America** and **HSBC** all experienced technical glitches that prevented customers from accessing account information, and in some cases, wouldn't allow them to made deposits or withdraw money. Spaceflight startup **Rocket Lab** failed to launch during a 10-day window due to unforeseen technical glitches. Glitches often have to do with degraded network connectivity or a miscalculation of the bandwidth needed. But a lot of times, glitches result from newer technologies, which we are learning break in unexpected ways.

Hackers attacked Ukraine's power grid using malware called Industroyer.

051

Proliferation of Darknets, Aided By Cryptocurrencies

Many people confuse the deep web–hidden parts of the Internet that aren't usually indexed by search engines–with darknets, which are niche spaces promising anonymity often for illegal activities. People go there to sell and buy drugs, guns, ammunition, security exploits (malware, ransomware) and your hacked data (passwords, credit card numbers and more). Cryptocurrencies have fueled activity in the dark corners of the internet, since they're encrypted and make tracking transactions nearly impossible. You can't just hop on to a darknet the way you **Google** your high school sweetheart. To access the hidden crime bazaars, you need special software such as **Tor** or **Freenet**, you need to know where you're headed, and you do need a bit of technical knowledge. It isn't illegal to take a walk through dark marketplaces. But there's plenty of good activity that takes place: whistleblowers hoping to shine a light on wrongdoing, political dissidents looking for asylum, and investigative journalists hunting down leads. As cryptocurrencies gain popularity and as the ecosystem blossoms to include more than just **Bitcoin**, we're likely to see more activity in darknets. Activists with legitimate concerns will advocate for new layers of protection, while law enforcement will receive training on how to navigate the dark web. For government and law enforcement, the challenge of training is that it is static. Those accessing darknets are typically also the ones building them.

052

New Open Source App Vulnerabilities

In 2017, a data scientist revealed a new kind of malware capable of infecting **OpenAI Gym**, **Elon Musk's** open-source toolkit for machine learning algorithms. It's just one example of a booming market for malicious tools that exploit vulnerabilities in open source applications and software. As the AI ecosystem grows to incorporate more open source code and community-built tools, it will be especially important to spot problems in advance. Many organizations use open source tools, and in the coming years they will need to perform daily–not occasional–security checks.

053

Selfie Security Using Faceprints

In 2011, the **Future Today Institute** forecast that within five years, we would see the advent of two or three-factor authentication using a combination of biometrics and gestures instead of passwords. Our timing was correct: in an effort to combat weak passwords (and weak password encryption), many companies are now using two-factor sign-ins that sidestep passwords entirely. **Apple** owns a patent for "low threshold face recognition," which helps its **iPhoneX** recognize faceprints, even in poor lighting or if we change our hairstyles. Chinese company Alibaba is using faceprints for payments, while **MasterCard** now offers selfie-scans: at the checkout, users can hold up their phones to pay with their faces. Faceprints are the new fingerprints. But it does raise an interesting question about the security of biometric databases. It's easy to change your password if you get hacked. How could you possibly replace your face, when the system's been designed to recognize your unique musculature and bone structure using thousands of data points?

054

Bounty Programs

The past several years have been dramatically successful for hackers. Security expert **Brian Krebs** says that the "market for finding, stockpiling and hoarding (keeping secret) software flaws is expanding rapidly" and went so far as to advocate for a compulsory bounty program. In response, a number of white hat (read: good hacker) bug bounty programs are becoming popular. In some cases, businesses solicit friendly hackers for paid work through platforms like **HackerOne**, which is being used by the **U.S. Department of Defense**, **Wordpress**, **Coinbase**, **Shopify** and **GitHub**. The DoD launched programs this year, including **Hack the Army**, **Hack the Pengaton** and **Hack the Air Force**, for the purpose of revealing problems. (It paid out $10,000 to two hackers, which was an unprecedented fee paid by the government for this kind of work).

CATASTROPHIC SCENARIO FOR THE NEAR-FUTURE OF FACEPRINTS

Amy Webb

It's easy to change your password if you get hacked. How could you possibly replace your face, when the system's been designed to recognize your unique musculature and bone structure using thousands of data points?

HACKER TERMS AND LINGO YOU NEED TO KNOW FOR 2018

ADWARE
Software that automatically generates online ads; it can also include spyware that tracks your browsing habits. It's because of adware that many people are turning to ad blocking software. (See the earlier "Blocking the Ad Blockers" trend).

ANONYMOUS
A collective of hackers, best known for its use of the Guy Fawkes mask and distributed denial of service (DDoS) attacks. Anonymous typically uses the hashtag #Ops when announcing a new campaign. Past ops included a takedown of the Church of Scientology and the Westboro Baptist Church.

ATTRIBUTION
Researching and tracking back the origins of an attack.

BACKDOOR
Developers intentionally install backdoors into firmware so that manufacturers can safely upgrade our devices and operating systems. The challenge is that backdoors can also be used surreptitiously to harness everything from our webcams to our personal data.

BLACK HAT
A malicious hacker; someone who hacks for personal gain.

BOT
Bots are automated programs that performs a simple task. Some–simple chatbots, for example–are completely harmless. Other bots can be programmed to repeatedly guess passwords so that a hacker can break into a website.

BOTNET
A botnet is a group of computers that are being controlled by a third party, and are being used for any number of nefarious purposes. For example, malware installed on your computer can run, undetected, in the background while hackers use your machine as part of a large spamming network.

BRUTE FORCE ATTACK
This type of attack is a laborious, methodical process where a hacker uses software to automatically guess every password it can to gain unauthorized entry into a network or computer.

BUG
A flaw or problem in a program that can be harmless or might allow hackers to exploit a system.

COMPILER
A program that translates source code into executable machine language. Compilers are used to surreptitiously allow hackers into various systems without changing the source code, making it easier for them to get into a computer or network without being noticed.

COOKIE
A small file sent from your computer's web browser to a server. Cookies help websites recognize you when you return, and they also help third parties track audience.

CRACKING
A basic term that describes breaking into a security system. Anyone "cracking" a system is doing so maliciously.

CRYPTO
Cryptography (or "crypto") is the art and science of encrypting data–as well as breaking encryption.

DEEP WEB/NET AND DARK WEB/ NET
The deep and dark net/web are actually two different things, though they're often conflated. The deep net or deep web is the vast trove of data that isn't indexed by search engines. Spreadsheets, databases and more that are stored on servers make up this space. The dark web/ net is made up of sites that are invisible unless you know how to use a special network, such as Tor, which knows how to find the dark side. Once there, you'll find what you might expect: pirated software and content, job ads for hackers, illegal drugs, human trafficking, and worse.

DENIAL OF SERVICE ATTACK (DOS)
This is when a hacker sends so many requests to a website or network that the traffic temporarily overwhelms the servers, and the site or network goes down.

DISTRIBUTED DENIAL OF SERVICE ATTACK (DDOS)
This is a DoS using a battalion of machines.

DEF CON
This is a big, annual conference for hackers that attracts people from all over the world. Discussions range from highly technical and academic to those about policy. It takes place in Las Vegas every August.

DIGITAL CERTIFICATE
These authenticate and approve the identity of a person, organization or service.

DOXING
When hackers root out and publish personally-identifying information about someone online.

HACKER TERMS AND LINGO YOU NEED TO KNOW FOR 2018.

DUMP
The term for a trove of data released by hackers.

DUMPSTER DIVING
Organizations and individuals who don't consistently use a shredder are opening themselves to dumpster diving, which is exactly what it sounds like: hackers go through garbage looking for any information that will help with an exploit.

ENCRYPTION
Using special code or software to scramble data so that it cannot be read by a third party, even if it is intercepted.

END-TO-END ENCRYPTION
When an encrypted message is scrambled on both ends, as it is sent and again as it is received.

EXPLOIT
The general term for leveraging a vulnerability in a piece of code, software, hardware or computer network.

FIREWALL
A system of software and hardware that's designed to prevent unauthorized access to a computer or computer network.

GREY HAT
Hackers are just like the rest of us. Some have malicious intent, others just want to fight the bad people, and some...have a certain tolerance for moral flexibility. Gray hats will use the tools and sensibilities of a black hat in the pursuit of justice.

HACKER
This term means different things to different people. People who tinker with code, to purposely manipulate it, are hackers. Some are good, and some are bad. In popular culture, "hacker" has taken on a distinctly negative connotation.

HACTIVIST
Someone who hacks for social or political reasons.

HONEYPOT
A system or network designed to look like a high-value target, but was instead built to watch hackers do their work and learn from their techniques.

INFOSEC
This is an abbreviation for "information security." Companies and professions that work within cybersecurity are known as InfoSec.

IRC
Internet relay chat protocol (IRC) has been around forever. It's the communication system used to have conversations and share files, and it's still used by hackers.

JAILBREAK
A way of removing the restrictive manufacturer's code from a device so that you can reprogram it to function as you desire.

KEYS
The code that, just like a physical key, is used to lock or unlock a system, encrypted message or software.

LULZ
A play on "lol" or "laughing out loud," black hats often use the term "lulz" to justify malicious work. LulzSec ("lulz security") is yet another offshoot of Anonymous, and it was credited with the massive Sony Pictures hack.

MALWARE
Any software program that's been designed to manipulate a system, by stealing information, augmenting code or installing a rogue program. Rootkits, keyloggers, spyware and everyday viruses are examples of malware.

MAN-IN-THE-MIDDLE (MITM) ATTACKS
This occurs when a hacker impersonates a trusted connection in order to steal data or information or to alter communications between two or more people.

METADATA
This is the data that explains what's in another set of data, such as a jpeg photo, or an email, or a webpage.

PASSWORD MANAGERS
These are third-party tools that you entrust your passwords to. Just remember one master password, and use it to unlock a database of all your other passwords, which should allow you to use a completely different password for every site and service you use. While managers are a good idea in theory, many are cloud-based. If a hacker gains access to your password manager, you're in big trouble. If you do use one, make sure to use complicated password at least 36 characters long with lots of special characters, numbers and capital letters.

PATCH
An after-market fix to address vulnerabilities.

PAYLOAD
The part of a computer virus that is responsible for the primary action, such as destroying data or stealing information.

PENETRATION TESTING
The practice of trying to break into your own computer or network, in order to test the strength of your security.

PGP
PGP stands for "Pretty Good Privacy," and you've probably seen a lot of PGP numbers showing up in Twitter and Facebook bios lately. PGP is a basic method of encrypting email (and other data). In oder to receive and read the message, your intended recipient must use a private key to decode it.

PHISHING
We've all seen a phishing attack at least once. They usually come in the form of an email from a trusted contact. Once you open the message or attachment, your computer, your data and the network you're on become vulnerable to attach.

PLAINTEXT
This is text without any formatting. In the context of cybersecurity, it also refers to text that isn't encrypted. Sony Pictures storing its passwords and email addresses in a basic Excel spreadsheet is an example of plaintext.

HACKER TERMS AND LINGO YOU NEED TO KNOW FOR 2018.

PWNED
South Park fans will remember Cartman using this word. It's geek speak for "dominate." If you've been hacked, you've been pwned.

RAT
RATs are Remote Access Tool. If you've used a remote login service to access your office computer while away from work, you've used a RAT. But RATs can be malicious, too. Just imagine a hacker using a RAT to take over your workstation.

RANSOMWARE
This is malware that allows a hacker to break into your computer or network and then take away your access until you pay a specified fee or perform a certain action.

ROOT
The root is the central nervous system of a computer or network. It can install new applications, create files, delete user accounts and the like. Anyone with root access has ubiquitous and unfettered access.

ROOTKIT
Rootkits are malware designed for root access. Often undetected, rootkits start running when you start your computer, and they stay running until you turn your machine off.

SHODAN
In Japan, a "shodan" is considered the first degree (read: lowest level) of mastery. In cyberspace, Shodan is a search engine for connected devices, allowing hackers access to baby monitors, medical devices, thermostats and any other connected device. It's intended to help people learn how to secure their devices, but obviously it can also be used against them. (See http://shodan.io).

SNIFFING
When you were a kid, if you drove around your neighborhood looking for open WiFi networks, you probably used a little device or a special computer program. Those are examples of sniffers, which are designed to find signals and data without being detected.

SPEARPHISHING
A more targeted form of phishing to smaller groups, typically within social networks or work environments.

SPOOFING
In general, anytime data is changed to mimic a trusted source, it's being spoofed. Changing the "From" section or header of an email to make it look as though it was sent by someone else. Black hats spoof emails by impersonating people you know, and then launch phishing attacks.

TOKEN
A small physical device that allows a trusted, authenticated user to use a service. Tokens are stronger than passwords alone, since they require both the password and the physical device to gain access.

TOR
The Onion Router, otherwise known as "Tor," was originally developed by the U.S. Naval Research Laboratory to route traffic in random patterns so as to confuse anyone trying to trace individual users. The Tor Project is the nonprofit now in charge of maintaining Tor, which is used by both white and black hackers, as well as journalists and security experts.

VERIFICATION
Ensuring that data, and its originators, are authentic.

VIRTUAL PRIVATE NETWORKS
Virtual Private Networks, or "VPNs," use encryption to create a private channel for accessing the internet. VPNs are necessary when connecting to public networks—even those at airports, hotels and coffee shops.

VIRUS
Malware intended to steal, delete or ransom your files. Mimicking the flu, this type of malware spreads like a virus.

VULNERABILITY
A weakness in computer software the hackers can exploit for their own gain.

WHITE HAT
Not all hackers are bad. White hats work on highlighting vulnerabilities and bugs in order to fix them and protect us.

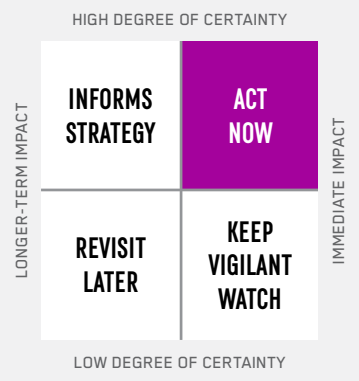
WORM
Worms are a certain kind of invasive malware that spreads like a virus.

ZERO-DAY EXPLOITS
In the hacking community, zero days (also written as "0day") are prized tools because they are undisclosed vulnerabilities that can be exploited. Once the flaw is revealed, programmers have zero days to do anything about it.

ZOMBIE
Just like the White Walkers in *Game of Thrones*, but machines! A computer, connected device or network that's been infected by malware and is now being used by the hacker, probably without your knowledge.

FIFTH YEAR ON THE LIST

PRIVACY



055-071

Key Insight

Americans express a consistent lack of confidence about the security of everyday communication channels and the organizations that control them – particularly when it comes to the use of technology. And they cite a deep lack of faith in the organizations charged with protecting the personal information they collect. While three-quarters of Americans say that it's important they know who's in control of their data, most struggle to understand the nature and scope of data that's being collected. Fully 91% of adults agree that consumers have lost control of how personal information is collected and used by third parties.[2]

[2] Pew Research Center, "The state of privacy in post-Snowden America," last accessed January 10, 2018.

055

The General Data Protection Regulation Takes Effect

Sweeping changes to data privacy regulations take effect in the European Union this year. Dubbed the **General Data Protection Regulation** (or **GDPR**), the new rules affect how companies can collect and use customer data. Those who don't comply will face hefty fines and litigation. The GDPR applies to everyone who uses customer data, regardless of where in the world you are.

056

Right To Eavesdrop/ Be Eavesdropped On

As we connect more and more devices to the **Internet of Things**–fitness trackers, mobile phones, cars, coffee makers–those devices are having extended interactions with each other and the companies who make them. Our devices aren't just talking to each other anymore. They're talking to one another, learning about us, and starting to talk about us. Increasingly, consumers are being left out of the conversation, unable to listen in and make sense of how their data is exchanging hands. A debate over **consumer rights** will heat up in 2018: should consumers be given the right to eavesdrop on what their own devices are saying, and who else is listening in?

Should consumers be given the right to eavesdrop on what their own devices are saying, and who else is listening in?

057

Defining What Constitutes Online Harassment

The **#MeToo movement** brought to light thousands of stories of sexual harassment and resulted in the outing of more than a dozen high-profile men throughout 2017. A shared **Google** document, dubbed "**The Shitty Media Men List**," was at one point circulating among female journalists, who entered the details of men who have sexually harassed women in the real world. When the list

Sweeping changes to data privacy regulations take effect in the European Union this year.

was leaked, some pointed the finger at the women, arguing that they were committing acts of online harassment simply by contributing to it. It's clear that we don't yet have clear definitions for what constitutes harassment. In the years ahead, we will continue to wrestle with what behavior is acceptable in virtual gaming worlds, in social media, in our mobile exchanges, and in general digital discourse.

058

Drone Surveillance

Drones are now coming in all shapes and sizes, and they can be used in a variety of settings for surveillance. Advanced camera technology can capture photos and video from 1,000 feet away, while machine learning software can remotely identify who we are and lock on to our bodies as we move around–all without our knowledge. **Interconnected drones** will enable the **mass tracking of people** at concerts, vehicles on the highway, amusement park attendees–which we may already expect from law enforcement. What's new for 2018 is that consumers will soon be able to use their drones for surreptitious looks at their friends, family and neighbors. (See also: Drones Section).

059

Personal and One-To-Few Networks

Personal networks are gaining momentum, though they are not new. Many closed networks have failed to find a strong base of users. However, in reaction to revelations about social media hacks and government-sponsored surveillance programs worldwide, private networks will gain momentum during the coming year. Journalists and others concerned about who might be looking through their email have switched over to **Signal**, which is an encrypted network for small groups, while **uProxy** is a peer-to-peer proxy tool allowing users access to the open internet from repressive countries. In 2015, **BitTorrent** released a public beta of **Project Maelstrom**, a web browser built on the same underlying technology as BitTorrent. The idea was a distributed internet system, circumventing traditional webhosts–and government agencies. Not too long after it launched, there was a major shakeup within the company, so Maelstrom never had the chance to gain momentum. The site may be down, but the idea is very much alive, especially in the wake of **net neutrality** rollbacks in the U.S., since a distributed browser system could prevent an ISP from throttling certain sites or users. In the social media category, keep watch on **Alively**, a private network to share videos started by Facebook's former Facebook Live product manager, and **MeWe**, which offers private social networking and file sharing.

060

Leaking

2017 was the year of leaks, and given our current political climate, we expect to see far more tech-enabled leaks in the coming year. Presidents accused staff of leaking confidential information to the press. WikiLeaks continued dumping information on the internet. Political activists prevented leaks from other political activists from entering the public. While many people seem eager to find and share information–not everyone agrees on what should be published, and by whom. The most famous leak in modern history happened when former **National Security Agency** contractor **Edward Snowden** leaked thousands of sensitive government documents. **U.S. Army Private Chelsea** (formerly Bradley) **Manning** uploaded a mountain of classified military and diplomatic documents to **WikiLeaks**, which has become the politically-embattled bastion for leakers. The U.S. government officially accused **Russia** of hacking into the **Democratic National Committee** and releasing sensitive emails. Meanwhile, the **International Consortium of Investigative Journalists**–a collaboration between 370 journalists from 76 countries–who spent a year reporting on a massive cache of 11.5 million leaked records showing the offshore holdings of 140 politicians from around the world, 12 current and former world leaders, and more. The records, known as a the "**Panama Papers**," were sent from a little-known law firm in Panama. In the summer of 2017, the **Senate Committee on Homeland Security and Governmental Affairs** issued a report entitled "State Secrets: How an Avalanche of Media Leaks Is Harming National Security" and cited 125 stories with leaked information that the committee considered damaging to national security. You can expect to see more coordinated leaking efforts in the year ahead.

061

Blocking the Ad Blockers

Ad blockers are software that automagically remove ads from webpages. People who use ad blockers are doing so either because ads slow down a site's loading time, or because the ads served are offensive, inappropriate for kids, or aren't safe

PRIVACY CONT.

for the workplace. In 2018, **Google** will launch its **Better Ads Experience Program**, which includes a native ad blocker built inside of Chrome. This should have a profound ripple effect throughout the digital advertising and publishing world, since Chrome accounts for more than half of the browser global market share–it has significantly more users than **Safari** and **Firefox** combined. Everyday users won't be subjected to those annoying pop-ups, auto-play ads and prestitials with countdowns–websites who don't comply will wind up with all of their ads blocked. But new research suggests that websites may just deploy advanced anti-adblockers, by dynamically rewriting the JavaScript code that verifies a clean site.

062

Organizational Doxing

"Doxing" is mining and publishing personal information about a person–"organizational doxing" is when this happens to an entire company. It's a term introduced by security expert **Bruce Schneier**. This isn't about stealing credit card information, but rather about making public the personal details of individuals, either to protest against policies, to embarrass companies or to blackmail companies into paying big ransoms to hackers. When **WikiLeaks** published emails stolen from the **Democratic National Committee**, it revealed troves of personal data and committee secrets causing embarrassment, some high-profile people lost their jobs, and it may have helped torpedo **Hillary Clinton's** run for office. It's one example of organizational doxing, but there have been several others in recent years: hackers stole and published the personal information of 37 million **AshleyMadison.com** users and the **North Korean** government stole and published an epic trove of corporate email from **Sony Pictures**. Every large company should consider itself a target. And in 2018, every election committee and campaign team should take added measures to safeguard digital security.

063

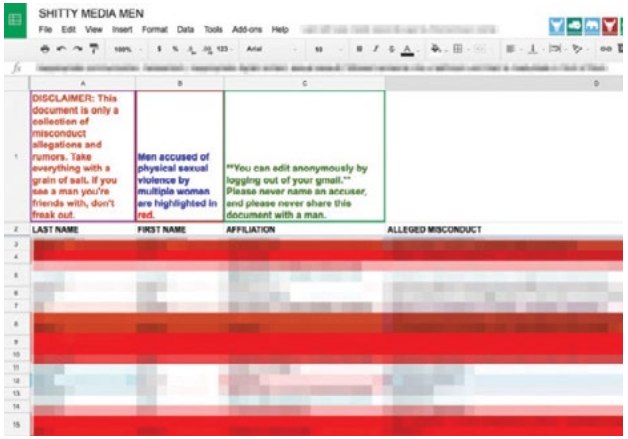
Anonymity

Anonymity is one of the digital trends we've been tracking as it has evolved during the past decade. The world needs anonymity, as it enables whistleblowers to come forward, and it shields those who otherwise might be persecuted for their beliefs. Digital anonymity allows us to band together in times of need, whether that's to raise money for a good cause or to push back against injustices. However, just as FTI forecast earlier, anonymity also means it's easier to leak sensitive information, troll social media users, and leave disparaging or libelous comments all over the internet. In 2015, we forecast that most anonymous sharing apps won't survive–indeed, **Secret** shut down, while **Yik Yak** came under fire for allowing cyber-bullying and for failing to prove that users real identities really are being protected. Our desire to post content anonymously won't abate, even as our desire for verification grows.

064

Authenticity

Sometimes a trend becomes so powerful–like digital anonymity–that it causes a fork, a divergent trend. As a result, we are now seeing new networks and services launch that offer **verification** and authenticity, proving that the content and sources are **reliable** and **accurate**, even if they are anonymous. We also expect to see changes made within social networks, which will prioritize accounts and posts that come from credible sources.

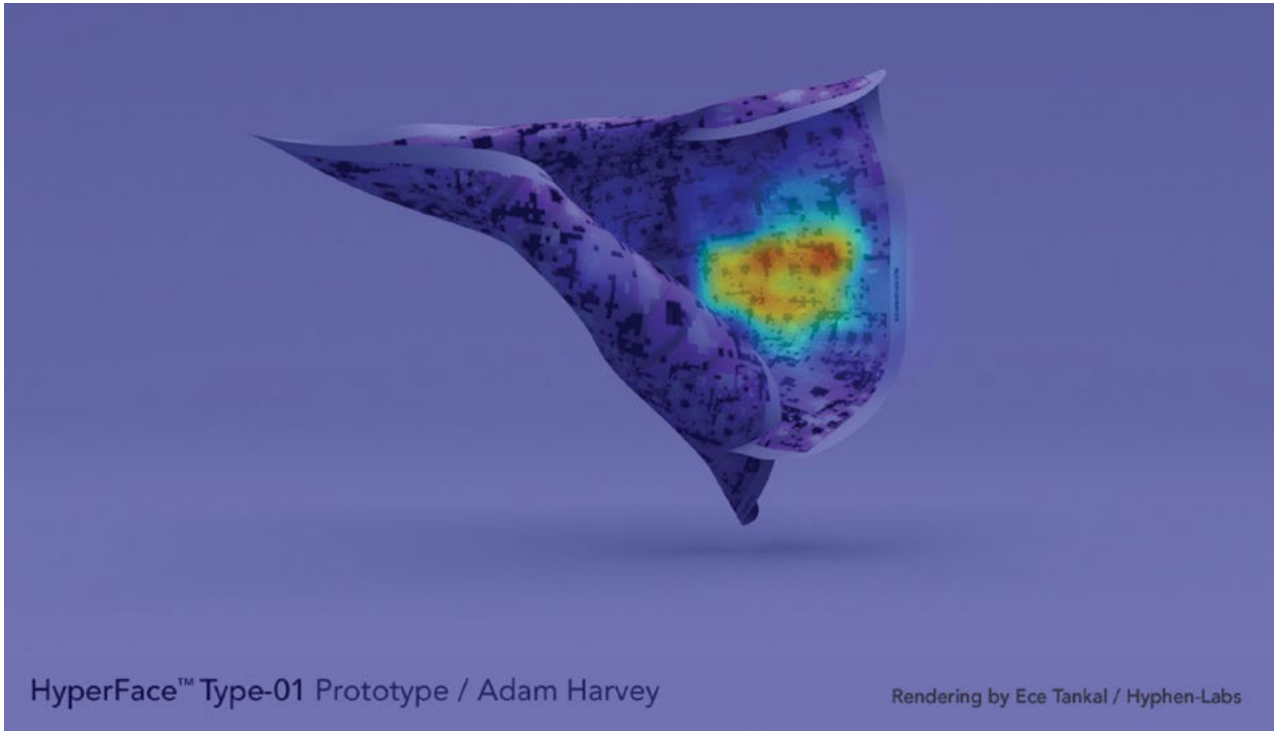


The "Shitty Media Men" list demonstrated that we don't yet have clear definitions for what constitutes harassment.

065

Differential Privacy

Consumers share vast amounts of their data, most often without realizing it. The free email services, mobile games, online storage–it all comes at a cost. Providers get unfettered access to customer data, which they can monetize by advertising back to consumers, or packaging that data for others. In the near-future, it should be possible to anonymize our data while still providing a benefit to those companies whose free services consumers now rely on. It's a technique called differential privacy, and it uses an algorithm to scramble data so that it cannot be traced back to each individual. Differential privacy is typically used alongside machine learning to study a large group in order to spot emerging trends, and the next evolution of it–homomorphic encryption–would allow a third party to submit an encrypted query and retrieve an encrypted result, obscuring the individual user (or users) along the way. **Microsoft** and **Google** have been researching how to use these techniques for better security in the cloud, while **Apple** now uses differential privacy



Project HyperFace is specialized fabric that confuses computer vision algorithms.

to study our data so that it can shore up its operating system and networks. What the company learns will eventually trickle back down to users in the form of more secure mobile systems. With the EU's **General Data Protection Regulation** laws going into effect this year, differential privacy will likely emerge as the new normal.

066

Anti-Recognition Cammo and Glasses

In response to our increasingly surveilled societies, some startups are developing specialized stickers, fabrics and glasses to help fool smart tracking systems. Researchers at **Carnegie Mellon** and at the **University of North Carolina at Chapel Hill** are have built a special pair of glasses that "facilitate misclassification," confusing the algorithms. The glasses succeeded in tests against the powerful **VGG** and **OpenFace** deep neural network systems. A project called **HyperFace** showed that a specialized pattern could be printed onto a hoodie to similarly confuse computer vision algorithms.

067

Digital Self-Incrimination

Fully 25% of Americans now own some kind of wearable device, and we expect that a third of Americans will own and use at least one wearable by 2022. Whether it's a connected fitness device, a smart earphone, or a pair of smart glasses, consumers will find themselves continuously monitoring—and being monitored—by third parties. Our legal system isn't keeping pace with technology, so we lack norms, standards and caselaw on how data collected from and produced by our wearables can be used. To date, **Fitbits**, pacemakers, and smartwatches have been used as evidence. In the **U.S.**, judges get to decide whether to allow data from wearable devices—or whether individuals still have a reasonable expectation of privacy if they've been actively sharing their fitness stats on **Instagram**. In **Germany**, a murder suspect's **iPhone** was used to corroborate police theories that he'd dragged his victim down a flight of stairs and dumped the body into a river nearby. Data from the **iOS Health App** showed that just after the murder took place, he was moving down a flight of stairs in the same location.

068

SWATting at Trolls

Trolls are everywhere online—they've become inescapable. 2017 seems to have brought out the worst in us all. Politics, taxes, immigration, racism, homophobia and sexism led to hateful images, messages and videos being posted all over the internet. Even the trolls got trolled. Blogger **Milo Yiannopoulos**, controversial for his far-right views, became famous for harassing people on **Twitter**. After a series of incendiary comments, which included a defense of pedophilia, he found himself besieged by an angry swarm of people and internet bots. YouTube star **Logan Paul** lampooned a suicide in **Japan** and his apology landed on deaf ears, as social media users worldwide descended to attack. His business deals were suspended, series he had in the works were canceled, and his digital influencer's channel was removed from **Google's Preferred premium advertising program**.

Our behavior online is seeping into the real world. In 2017, gamer **Tyler Barriss** marketed himself as a middleman to gamers wanting to take revenge by "swatting" for hire—prank calling in the kinds of

attacks that result in local police forces sending in their SWAT teams. Barriss made a prank call to police in Witchita, Kansas, claiming that he'd murdered his father and that he was holding others hostage–but he accidentally gave them the address of an innocent family, rather than the gamer he'd been hired to harass. The SWAT team showed up and opened fire, killing one. Without significant behavioral changes, darker days are ahead. There may be a tiny bit of light: one of **Alphabet's** tech accelerators, Jigsaw, has launched a number of projects hoping to make the internet safer, including **Conversation AI** and **Perspective**, which are tools intended to use machine learning to identify the language of abuse and harassment.

SWATting: Prank calling in the kinds of attacks that result in local police forces sending in their SWAT teams.

069

Revenge Porn

As of publication, 38 states and the District of Columbia now have revenge porn laws in the U.S., yet that hasn't stopped the spread of hateful videos. Last year, we learned that hundreds of **U.S. Marines** had been sharing nude photos of female service members from every branch of the military via a private **Facebook** group and on an image-sharing message board called **AnonIB**. Staff within the **U.S. Senate,** the **U.S. Navy**, and even **President Donald Trump's Executive Office** have accessed revenge porn websites. In the U.S., there is no national law banning revenge porn. Even with new and proposed legislation throughout Europe, revenge porn cases are still on the rise.

070

Eye In The Sky

Beginning in January 2016, **Baltimore police** deployed "wide-area surveillance" run by Ohio-based **Persistent Surveillance Systems**. Aircraft carrying high-resolution cameras fly over the city continuously for up to 10 hours at a time, photograph a 30-square-mile radius, and then send that information back down to analysts on the ground. Wide-area motion imagery technology allows police to surreptitiously track any person or vehicle within the area, and it's been requested by the **Miami-Dade Police Department** and in cities elsewhere in the world. The **ACLU** and a number of privacy experts have asked for a review of the system, citing the infringement of constitutional rights.

071

Law Enforcement Using Recognition Algorithms To ID Faces

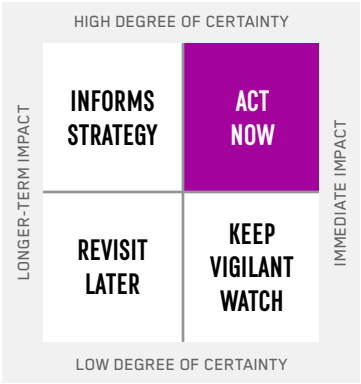
The **Washington County (Oregon) Sheriff's Office** has deployed facial recognition databases capable of figuring out whether someone's ever been in the county jail–simply by scanning their face. The software was built using **Amazon's Rekognition**, and image and video analysis engine that stores the County's repository of mugshots in Amazon's cloud. In a blog post about the system, an information systems analyst from the Sheriff's Office writes: "Early in 2017, an unknown suspect visited a hardware store, filled a basket with expensive items, and scanned them at the self-checkout kiosk. Before finishing the checkout process, the suspect picked up the merchandise and walked out of the store. The checkout kiosk's camera captured a great shot of him. Typically, this would initiate a manual process

Signal is an encrypted network for small groups.

where we show the image to multiple law enforcement officers and hope that someone recognizes the suspect. This time, we ran the image through our facial recognition system and got four hits with more than 80% similarity according to Amazon Rekognition. We noticed that one of the men looked very familiar to us. We gave his name to the detective in charge of the investigation. The detective did a quick search of **Facebook** and found a picture of him. In that picture, we noticed many facial similarities. The best part? He was wearing the same hoodie as the man captured on camera who was suspected of the theft." Nationally, the **FBI's Next Generation Identification Interstate Photo System**, or **NIG-IPS**, is a giant database storing more than 30 million photos to support criminal investigations. Machine learning algorithms are deployed to find and compare those photos to people who are thought to commit crimes. There's an obvious privacy concern: not everyone in the database is a criminal, and machines don't always get matches right. They're more likely to misread people of color than caucasians.

TENTH YEAR ON THE LIST

DATA



Consumers use their fingerprints and faces to unlock systems and devices.

072-075

Key Insight

Data is a very large trend category with numerous stakeholders, applications and emerging ideas. In the coming year, **Big Data** will continue to be a buzzword and a trend throughout many industries and fields. From collecting it to parsing it and making it easier to search, we will continue to see lots of developments in 2018. Businesses will want access to analytics tools in order to make important business decisions, while government agencies will rely on data to determine funding for various programs. Consumers have become more aware how much personal data they're creating—and who has access to it. Here are some data-related trends worth tracking in 2018.

072

Data Retention Policies

Many organizations—from financial institutions to universities, hospitals, veterinarians, churches, Fortune 500 companies and beyond—store data for compliance, business or customer convenience. In the year ahead, every organization will need to address best practices in data retention, with an eye toward security. You would be surprised to know how few organizations have responsive data retention policies that are updated according to security issues—and for that matter, how many organizations don't have policies at all.

073

Encryption Management

We've seen dozens of big attacks in the past 24 months, and yet many of the organizations we entrust with our data are either not using encryption or are using tools that are out of date. Hackers know this, so we should expect more attacks in the coming year. While encrypting data makes it harder to hack, encryption can also make it harder for staff or consumers to make legitimate use out of the data. In the near-future, companies will need to devote serious resources into shoring up their digital security, or risk losing millions of dollars cleaning up after a breach.

074

Who Owns Your Personal, Biometric Data?

Consumers use their fingerprints and faces to unlock their phones. They share their heartbeats and steps with their fitness trackers. As our devices become smarter, they'll start collecting even more personal biometric data. But who actually owns the rights to your biometric information? Is it a commodity that can be legally bought and sold without your permission? In the **U.S.**, biometric data falls under a bunch of different state and federal regulations, and the issue will likely head to court in the near-future. That's because of professional athletes—and in particular the **National Football League Players Association**—who are making sure that professional athletes get a say in who owns their data, how it can be shared outside the teams, and whether it can be used to earn a profit.

075

Global Data Scientist Shortages

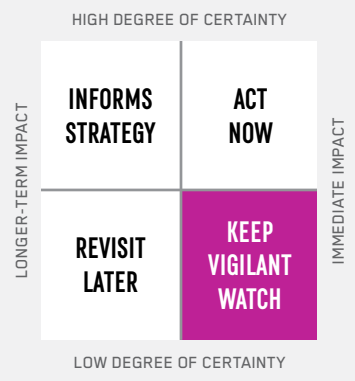
"Data scientist" used to be a job that no one wanted, yet now it's one of the most sought-after positions. There just aren't enough skilled data scientists to fulfill all the work available—some estimates show a 50% gap between upcoming supply and demand. Industries including pharmaceuticals, finance, insurance, aerospace, foundations, government and travel are all in need of employees who know how to work with the troves of data they're collecting. As a result, we're facing a data scientist shortage. As the needs for data scientists spike, we're going to either have to retrain wide swaths of workers or wait for the next generation of skilled workers to graduate from college. Some universities, seeing workforce needs changing, will launch new graduate programs and centers in data science. Ethics and diversity will hopefully be a mandatory part of those programs, so that our future data scientists are aware of possible algorithmic discrimination and problematic data training sets.

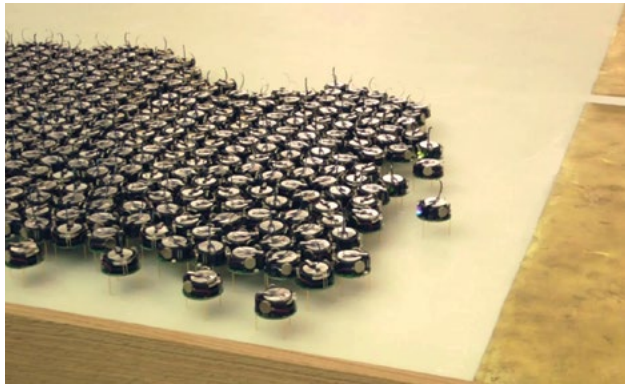
ADVANCED ROBOTICS

FIRST YEAR ON THE LIST

Self-Assembling Robots

076





Robots at the Harvard University Self-Organizing Systems Research Group take turns assembling for action.

Key Insight

A new generation of robots are capable of self-assembly, enabling them to merge, split and repair themselves. We'll eventually ingest them to deliver medications–and they'll find work on construction sites and factory floors.

Examples

The **MIT Computer Science and Artificial Intelligence Laboratory (CSAIL)** recently debuted **Primer**, a tiny self-assembling robot that is controlled by magnetic fields. The team has built a tiny robot that seems to act much like video game avatars: it can put on exoskeleton parts to help it walk, roll, sail or glide better, depending on the environment. Researchers at the **Georgia Institute of Technology** and at **Peking University** (China) discovered a new technique that mimics automatic origami–in initial testing, structures were able to fold and unfold on their own using inexpensive liquid polymers and LED projector bulbs.

What's Next

Self-assembling robots offer a host of possibilities for medicine, manufacturing, construction and the military. When it comes to applications for the future of health, CSAIL director Daniela Rus said her team imagines "robots like this could become mini-surgeons, squished into a pill that you swallow." Because magnetic fields are able to transmit through our bodies without harming us, future surgeons could ask patients to ingest nanobots and then direct them magnetically in order to deliver targeted therapies.

Watchlist

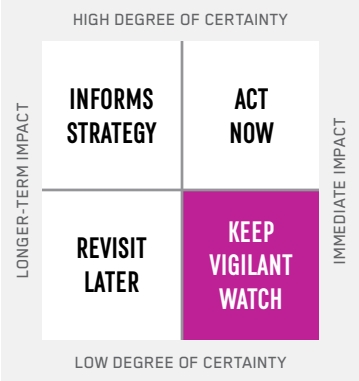
MIT CSAIL; Georgia Institute of Technology; Peking University.

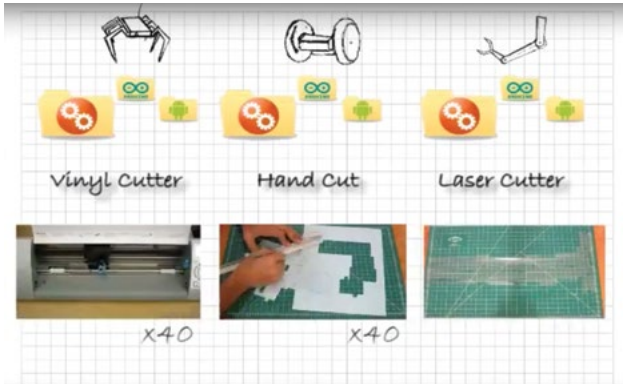
[3] *"Shape-shifting origami robot swaps bodies to roll, swim or walk," New Scientist. Last accessed January 10, 2018.*

FIRST YEAR ON THE LIST

Robot Compilers

077





In the future, we'll tell computer systems what tasks we need completed, and they will automatically fabricate new robots for the job.

Key Insight

Today, the process of designing, programming and building robots is time intensive–and the capabilities are limited by the original specifications. In the future, advanced compilers will enable much faster conceptualization and fabrication for a host of different tasks.

Examples

Researchers from the **MIT Computer Science and Artificial Intelligence Laboratory** (CSAIL), **University of Pennsylvania** and **Harvard** have been working to develop new methods for rapid robot fabrication. In 2016, they published their findings: 3D robotic systems can be produced using basic software and programmed using natural language commands.

What's Next

Since fabricating programmable robots isn't exactly a simple, DIY weekend project, research into robot compilers is incredibly promising–it could enable people with limited technical knowledge to sketch, design, print, fabricate and control a robot from their imagination. There are also tangible applications for the enterprise: robot compilers would offer greater efficiencies, big cost savings and increased production for manufacturers in every industry.

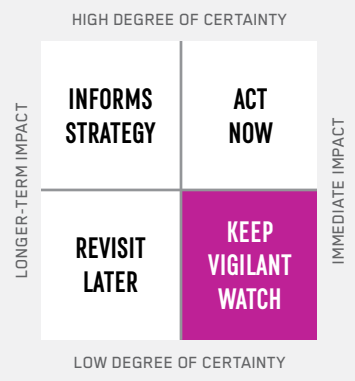
Watchlist

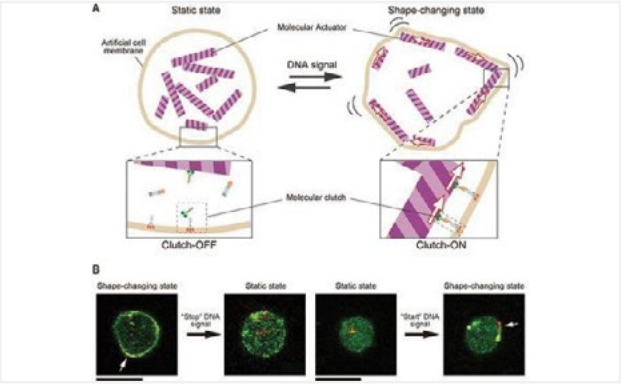
MIT Computer Science and Artificial Intelligence Laboratory (CSAIL); University of Pennsylvania; Harvard University.

FIRST YEAR ON THE LIST

Molecular Robotics

078





A molecular robot consisting of biomolecules, such as DNA and protein, has now been developed by a team of scientists at Tohoku University in Japan.

Key Insight

DNA can be used to make robots—but the process isn't easy.

Examples

Scientists at the **Wyss Institute for Biologically Inspired Engineering** at **Harvard University** have discovered that robots and our DNA share the ability to be programmed in order to perform tasks. Just like our next-gen robots, molecules are capable of self-assembly, they can react to their environments and they can be programmed. The question for 2018: how might we use molecular robots in the future?

What's Next

A team of scientists at **Arizona State University** and at Harvard are creating single-stranded origami shapes using one long strand of DNA—which is capable of self-folding. It turns out that RNA can be used, too—and both can be produced inside of living cells. Molecular robotics will someday be used on all life forms to provide targeted therapies as well as genetic augmentation.

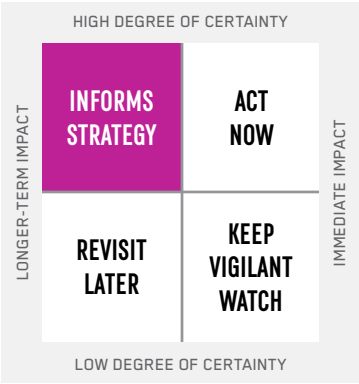
Watchlist

Harvard University; Arizona State University; Johns Hopkins University; Stanford University; University of Cambridge; Imperial College London; Nanyang Technical University; Georgia Institute of Technology; Tsinghua University; Tohoku University; Dana-Farber Cancer Institute; NuProbe; Ultivue; Office of Naval Research; U.S. Army Research Office; National Science Foundation's Expeditions in Computing Program.

SECOND YEAR ON THE LIST

Collaborative Robotics

079



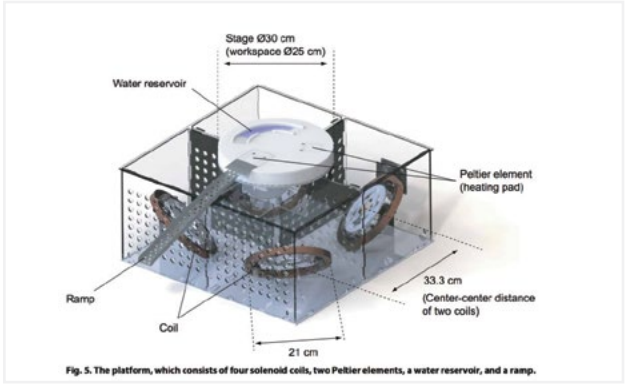


Fig. 5. The platform, which consists of four solenoid coils, two Peltier elements, a water reservoir, and a ramp.

The next generation of robots will work cooperatively.

Key Insight

Robots that communicate in real-time and cooperate on projects make a strong team.

Examples

Robots are now able to work together, as a team, without human intervention. Under the **European Union's Horizon2020** project, researchers at the **Karlsruhe Institute of Technology**, **EPFL**, **Sapienza Università di Roma**, and **University College London** have developed an autonomous humanoid robot assistant for engineers that interacts with other robots and can learn from its human coworkers. Researchers at **Carnegie Mellon University** have built collaborative robots that are designed to work together. In their recent work, a robot named **Baxter** is stationed at a table working on a project. Once completed, another robot on the team–**Co-Bot**–picks up the item and hands it to a human. Teams of collaborative robots can communicate to each other, on their own, about when to wait, when to move, to carry out an activity, or even to ask what to do.

What's Next

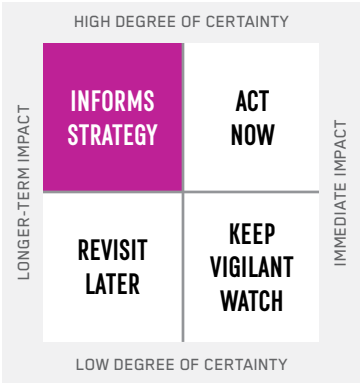
In the near-future, collaborative robots will play a key role in warehouses and distribution centers, automating the tasks previously performed by humans. There are a number of other immediate use cases: collaborative robots will help on construction sites, in factories, and during military operations. In the farther future, collaborative robots will underpin fully-automated supply chains, logistics services and deliveries.

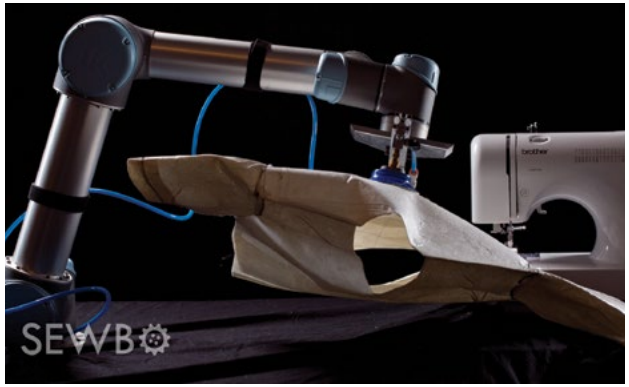
Watchlist

Amazon; Karlsruhe Institute of Technology; EPFL; Sapienza Università di Roma; University College London; Carnegie Mellon University; MIT's Interactive Robotics Group; SoftBank Group; SoftBank Robotics Corporation; Ocado Technology; iRobot; KUKA; SpaceX; Robotshop; Festo; Lockheed Martin; Northrop Grumman; Raytheon; DARPA; Autonomous Solutions; Energid Technologies; Boston Dynamics; Denso; Hitachi; Kawasaki Heavy Industries; Mitsubishi Electric; ABB Robotics; Aethon Inc.; FANUC Robotics; EPSON Robotics; Seegrid; Toyota; Honda; ULC Robotics; VEX Robotics; Yamaha; University of Tokyo; Johns Hopkins Applied Physics Laboratory.

SECOND YEAR ON THE LIST

Ethical Manufacturing





The Sewbo robot created a complete garment without human assistance.

080

Key Insight

Could robots bring the end of forced labor and lead a new era of ethical manufacturing?

Examples

Recent advancements in robotics are proving that soon, humans may no longer be required to perform labor-intensive manufacturing jobs. While this certainly means that people will be out of certain kinds of work, it does imply the end of bonded, forced and child labor—not to mention slavery—which unfortunately has become commonplace in places like **China**, the **Philippines** and **Bangladesh**. In October 2016, a **Canadian court** allowed a lawsuit brought by Eritrean workers against **Nevsun Resources**, a mining company: it was the first time in history that a tort claim for modern slavery went ahead in Canada. Meanwhile, in September, the **Associated Press** published a searing account of foreign fishing workers, confined and forced to work on U.S. fishing boats. The AP's investigation revealed a disturbing present-day reality: fishermen who were forced to use buckets instead of toilets, suffered sores from bed bugs and didn't have enough food to sustain them.

What's Next

Look for a number of new advancements in robotics that further reduce the need for human labor, such as the **Sewbo**, which is similar to a traditional sewing machine but also has a smart robotic arm, allowing it to both sew and assemble an item of clothing. **Elon Musk's** giant **Gigafactory** will soon employ hundreds of robotic arms and "automated guided vehicles," essentially mobile robots that transport items from one area to another.

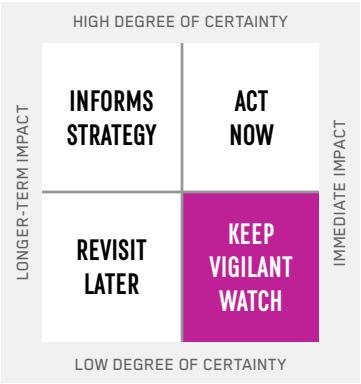
Watchlist

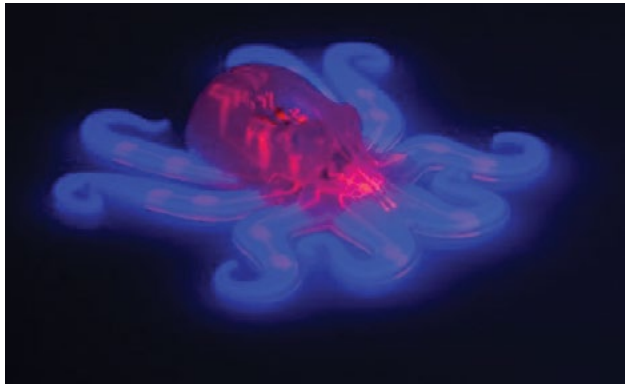
National Association of Manufacturers, Alliance For American Manufacturing, Tesla, Sewbo, Carnegie Mellon University; MIT's Interactive Robotics Group; Alphabet (Google); Amazon; ABB Robotics; Aethon Inc.; ULC Robotics.

SECOND YEAR ON THE LIST

Soft Robotics

081





Harvard University researchers created a self-contained soft robot.

Key Insight

This is a relatively new field of robotics research. Imagine robots that are squishy and can operate in unpredictable environments.

Examples

Researchers at numerous universities are working on hydraulically articulated soft robots. Some look like fish, while others resemble gelatinous cephalopods. Bioengineering researchers at the **University of California at Los Angeles** developed a tissue-based soft robot that mimics the biomechanics of a stingray. Scientists at the **BioRobotics** Institute at the **Scuola Superiore Sant'Anna** in Pisa, Italy, created a **robot octopus**, capable of replicating the animal's agile motions. In order to replicate the biology of an octopus, they built computer models using exact measurements and then experimented with a number of soft actuators to develop artificial muscles. Researchers at **Worchester Polytechnic Institute** have been working on a robotic snake.

What's Next

Soft robots mean that someday soon, we will be able to enter and explore environments previously unreachable by conventional methods: deep ocean waters, the terrain of **Mars**, and perhaps even the gushing rivers of blood inside our own bodies. But soft robotics also offer promise to stoke survivors—soft, robotic exoskeletons could be used for rehabilitation and as assistive devices. This technology could also be used to develop personalized tissue patches for heart attack patients.

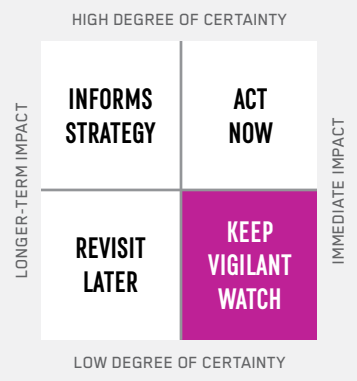
Watchlist

University of California at Los Angeles School of Engineering; Scuola Superiore Sant'Anna; Worchester Polytechnic Institute; Harvard Biodesign Lab; MIT's CSAIL's Soft Contact Modeling Group; MIT Media Lab; Johns Hopkins Applied Physics Laboratory; DARPA.

THIRD YEAR ON THE LIST

Human-Machine Interfaces

082



Elon Musk and his new company Neuralink are hoping to commercialize human-machine interface technologies.

Key Insight

Researchers are finding new ways to connect humans and mammals directly to computers. With these human-machine interfaces, people can communicate via thought alone, which promises new options for those suffering from stroke and paralysis.

Examples

At the **University of Washington's Center for Sensorimotor Neural Engineering**, researchers built a system allowing one person to transmit his thoughts directly to another person. Using electrical brain recordings and a form of magnetic stimulation, one researcher sent a brain signal to another person elsewhere on campus, causing his finger to tap a keyboard. Meanwhile, researchers at the **Center for Neuroengineering at Duke University** have built a real-life Iron Man suit, allowing a young man suffering from complete paralysis of his lower body to walk out onto a soccer field and kick the first ball of the World Cup.

What's Next

Last year, **Elon Musk** announced **Neuralink**, a new company he founded to commercialize human-machine interface technologies. His reasoning: Musk believes that humans should merge with machines as we enter the age of AI. Meanwhile, the team at **Duke** is working on a "**Brainet**," which would connect the brains of a group of mammals to harness and direct their neural activity. One successful experiment: to see if networking rats together would allow researchers to solve a basic forecasting problem that individual rats struggled to complete on their own. In every trial, the Brainet successfully solved the problem, and performance improved the more the rats worked together. This work has a practical and altruistic purpose: to help victims of stroke or traumatic brain injury regain their cognitive abilities and motor function. Rather than having to relearn, they need only reload those memories.

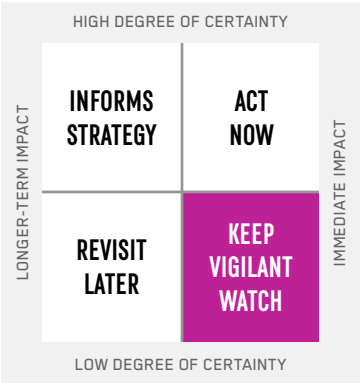
Watchlist

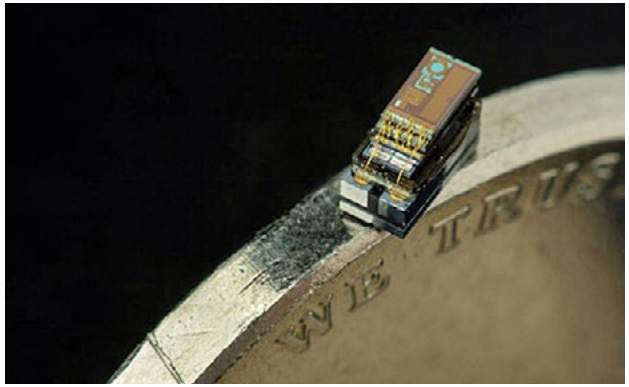
Elon Musk; Neuralink; Duke University's Center for Neuroengineering; University of Southern California; University of Washington's Center for Sensorimotor Neural Engineering; Johns Hopkins University; Carnegie Mellon University; Starlab; Case Western Reserve University; Penn State University; Johns Hopkins Applied Physics Laboratory; DARPA.

SECOND YEAR ON THE LIST

Smart Dust

083





Tiny computers the size of dust will be used to gather data, record video and take photos.

Key Insight

These are computers, no larger than a speck of dust, that are light enough they can suspend in the air. They could someday also be injected or breathed in, undetected.

Examples

If you watched the "Arkangel" episode of ***Black Mirror*** (season four), you're already familiar with smart dust. For years, researchers have been hard at work on miniaturization, as they try to shrink computers as much as possible, down to the size of sand or dust. Each particle-computer consists of circuits and sensors capable of monitoring the environment, and even taking photographs. Scientists at the **University of California Berkeley** developed what they call "neural dust," which are microscopic computers that work alongside remote ultrasound to send and receive data about the brain. Meanwhile, researchers at the **University of Stuttgart** figured out how to print tiny 3D lenses—120 millionths of a meter in diameter, or about the size of a grain of sand.

What's Next

Researchers believe that this technology will dramatically change our approach to medical imaging. Rather than relying on our current endoscopic technology, which is bulky and invasive, a patient could simply inhale smart dust. Beyond medicine, trillions of smart dust particles could be released in the wind to measure air quality or take photos. But we must also consider other use cases: would you know if you'd inhaled rouge smart dust on a windy day? In the farther-future, could this technology be used to track us surreptitiously?

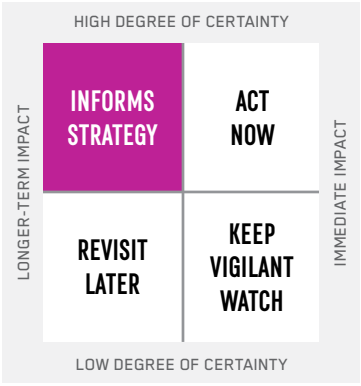
Watchlist

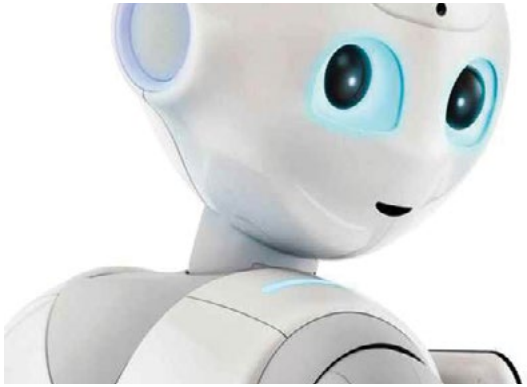
University of Stuttgart; University of California Berkeley; Stanford University; University of Washington; Purdue University; USC Robotics Research Lab; DARPA.

SECOND YEAR ON THE LIST

Personal Robots and Butlers

084





Pepper is a Japanese robot for use at work and at home.

Key Insight

The first personal robots and butlers, capable of doing multiple tasks, are coming to market soon.

Examples

Many countries, including **Japan**, **Italy**, and **Germany**, are facing rapid demographic shifts. In Japan, one in four people are now age sixty-five or older–there aren't enough people working to support both retirees and children. Science and technology will eventually stand in for the lack of people: robots will assist with everything from elder care, to medical assistance, to everyday companionship. Unsurprisingly, this first generation of companion robots is being built in Japan. **Panasonic** and Japan's largest homebuilder **Daiwa House** created an AI-powered robot that can sort and fold your laundry. **Honda** and **Sony** have launched a fleet of personal robots in the past year, offering both companionship and some help with the housework.

What's Next

Within a generation, there will not be enough people to make Japanese society work as it does today–but Japan isn't alone in its demographic shift. Anyone interested in the future of robotics would be wise to look not to **Silicon Valley**, but instead to universities and R&D labs in Japan, where extensive research on the next generation of robot companions is already underway. Out of necessity, robots–mechanical systems, artificial intelligence, and automated services–will act as productive, emotionally-intelligent stand-ins for a younger generation that was simply too small in numbers.

Watchlist

SoftBank Robotics; Panasonic; Sony; Honda; Mitsubishi Heavy Industries; Eifer Elektro Firma; Fujitsu; AMY Robotics; COEX; Bioinspired Intelligent Mechatronics Lab, Ritsumeikan University; ARP; Microstar; Koenn; Shinpo Electronics; LG; Sharp; Toyota; MIT Media Lab; Buddy; Nanyang Technological University; Sony; Tokyo University; Johns Hopkins Applied Physics Laboratory.

CATASTROPHIC PERSONAL ROBOTICS SCENARIO – WHAT HAPPENS WHEN HUMANS PREFER SEX WITH ROBOTS?

Amy Webb

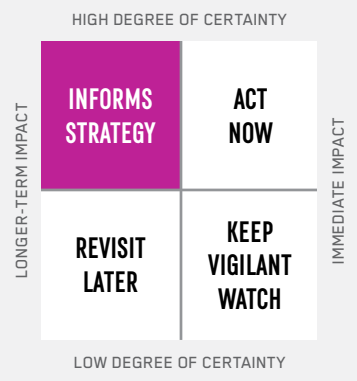
Would you watch a robot stripper pole dance for dollar bills? It turns out that a lot of people did at the Sapphire Gentleman's Club in Las Vegas earlier this year. The robo-strippers didn't look exactly like humans–in place of their heads were CCTV surveillance cameras retrofitted with red lights–and only their torsos, buttocks, thighs, forearms and calves were covered in plastic molded to resemble realistic (but shiny) skin. But they were, of course, wearing high heels, and their movements closely mimicked the real thing.

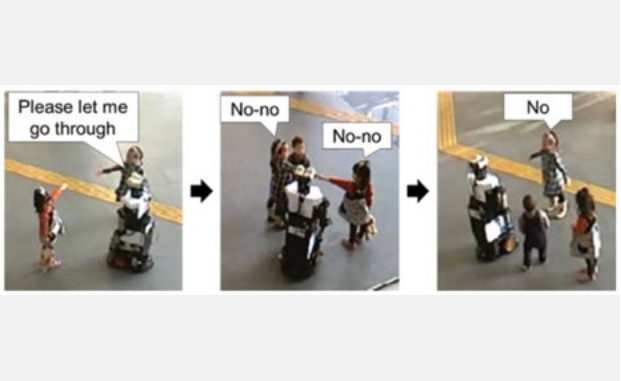
Pole dancing robots are gimmicky, but they could also portend a future where social isolationism helps usher in an era of AI-powered personal robots, programmed to learn from us, laugh at our jokes, and never reject our advances. We're already part way there. In 2018, Realbotix adds a male sex robot to its lineup; Harmony, its female bot already on the market, has a fully customizable body and personality. The male bot will include a detachable penis, enabling the owner to dictate when it's aroused. It's plausible that robots, as they become more lifelike and socially acceptable, will prove a better option for casual sex–we wouldn't have to worry about sexually-transmitted diseases, unwanted pregnancy or rape. We could wind up healthier. But since the robots will be available in wealthy nations first, it's plausible that it might take longer to develop serious relationships with other humans. We could see birthrates tank in the world's largest GDPs–U.S., Japan, Germany, the U.K., France, Brazil and Korea–which could eventually lead to new immigration rules and a shift in geopolitical power.

FIRST YEAR ON THE LIST

Robot Abuse

085





The Robovie-II is bullied by children at a mall in Osaka.
[Image: ATR Intelligent Robotics and Communication Laboratories]

Key Insight

Personal robots are still launching, and already we've seen the first instances of humans bullying robots.

Examples

Researchers at **ATR Intelligent Robotics and Communication Laboratories**, **Osaka University**, **Ryukoku University**, and **Tokai University**, in Japan launched an experiment to measure human empathy towards robots. They deployed a small, assistive robot called the **Robovie-II** through a mall in Osaka without a human minder. If someone walked into the robot's path, it would politely ask the human to move. Adults complied–but children didn't. And if children were unsupervised, the researchers found the were intentionally mean, kicking the robot, yelling at it, and bullying it. Another study, from the **Human Interaction With Nature and Technological Systems Lab** (HINTS) at the **University of Washington**, discovered that children didn't show the same kind of empathy they do with other humans. In the study, 60% of the kids thought that Robovie had feelings–and still, over half of them thought it was fine to lock him in the closet.

What's Next

When it comes to our interactions with robots, what constitutes a moral violation? What rights should robots have, given that so many companies are building smart interfaces and cognitive systems? If we're teaching machines to think, and to learn from us humans, what are we programming into our future generations of robots?

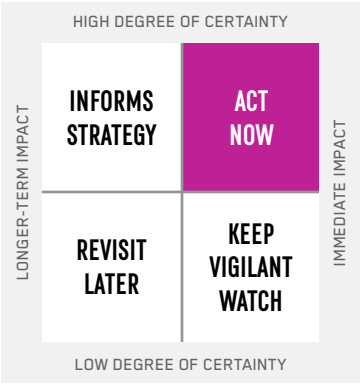
Watchlist

University of Washington; ATR Intelligent Robotics and Communication Laboratories; Osaka University; Ryukoku University; Tokai University; SoftBank Robotics; Panasonic; Sony; Honda; Mitsubishi; Bioinspired Intelligent Mechatronics Lab, Ritsumeikan University; LG; Sharp; Toyota; MIT Media Lab; Buddy; Sony; Tokyo University.

SEVENTH YEAR ON THE LIST

3D Printing

086



Scientists are already printing replacements for human tissue and bone.

Key Insight

3D printing has moved from the fringe to the mainstream, offering new opportunities for medical and biosciences, manufacturing and artists.

Examples

3D printing isn't just for keychains anymore. In 2018, we'll see new advancements allowing the printing of different materials, as well as additive and subtractive manufacturing. In the past year, scientists have printed the scaffolding that matches human brain and lung tissue. In an experiment at **Northwestern University's Feinberg School of Medicine**, researchers successfully printed and implanted mouse ovaries which resulted in a successful pregnancy. **Russian** startup **Apis Cor 3D** printed an entire house. Researchers at the **School of Food and Nutritional Sciences** and **University College Cork** printed cheese from raw, natural materials. In the next year, we'll see companies custom-printing orthotics and footwear, eyeglasses and athletic equipment. Soon, "one size fits all" won't need to fit any one person ever again.

What's Next

If you're thinking **Star Trek Replicator**, you're not far off. Researchers are working towards scanning and producing 3D objects in seconds—over time, this technology will be used in surgical centers, to rapidly print replacement valves and knees using your own biomatter as models.

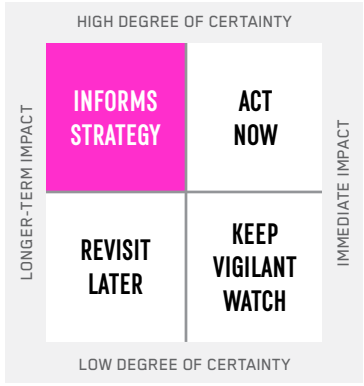
Watchlist

Autodesk; Kodak; Ethereal Machines; Northwestern University's Feinberg School of Medicine; University College Cork; Apis Cor; Organovo; MIT Media Lab; GE; Formlabs; Aurora Labs; Arc Group; ExOne; Voxeljet; Stratasys; HP; Shapeways; MakerBot; University of Illinois Urbana; University College London.

TRANSPORTATION

SEVENTH YEAR ON THE LIST

DRONES



DJI makes consumer drones for the masses.

087-096

Key Insight

As 2017 came to a close, the FAA announced that there were more than 1 million drones registered in its Drone Registry program. Fully 878,000 drones were registered by individuals and enthusiasts, while the remaining 122,000 were drones used for public and commercial purposes.

Drone demand is not only increasing in the United States, but across Europe, Asia, and other countries in North and South America. The advancements seen in drone technology are fueled primarily by anticipated military and commercial uses. Widespread future use of commercial drones will likely depend on standardizing regulations. If companies are forced to comply with patchwork regulations in different locations, it would make compliance burdensome.

087

Flying Taxis

Don't call them flying cars–because they're not. In 2018, several companies will bring flying taxi concepts to consumers. These autonomous vehicles–a high-tech cross between a quadcopter and helicopter–hope to carry one or two passengers at a time without needing a pilot. Startups including **Ehang**, **Volocopter** and **Uber Elevate** are all testing taxi drones.

088

Autonomous Underwater Vehicles (AUVs)

Researchers at **MIT** have developed underwater drones with cognitive capabilities, called AUVs. After giving them a series of parameters–how far to stray, how far above the seafloor to move, what to explore and the like–these drones can function on their own. If something unforeseen happens which impedes the drone's ability to complete its designated task, it can decide whether to continue or to return to base. AUVs can be used for a host of purposes, from environmental mapping and texting, to military support. Some have suggested AUVs might be used for more nefarious purposes, like transporting illegal goods.

089

Drone Delivery

Towards the end of 2016, commercial drone deliveries launched. U.S.-based **Zipline** brought its drone delivery system to **Rwanda**, where it delivered vital blood supplies. **UPS**, **Amazon** and **DHL** all tested their own fleets of drones. Legislation will soon catch up with the technology. We anticipate that aviation authorities will start to act in 2019-2020, at which point commercial drone deliveries will finally take flight in earnest. This means lots of new stories to cover, especially for reporters working logistics and business beats–and it potentially means the end of newspaper delivery by humans, forever.

090

Increasing Patents and Calls For New Regulation

Whether drone delivery services ever get off the ground largely hinges on legislation and corporate development. If the number of patents Amazon was awarded in 2017 for drone related technologies (43+) is any indication, retailers are anticipating government approval. **Amazon** was granted a patent for a self-destructing drone that can disassemble itself in case of emergency, while **Walmart** was granted a patent for a drone that delivers items off store shelves to people while they shop. In late 2017, the **Trump Administration** announced it had authorized a three-pilot program to test drone traffic under different conditions in "innovation zones." In **Europe**, the **E.U.** has tentatively agreed to regulations, which at publication date was still waiting for authorization from member countries. **Canada**, the **United Kingdom**, and the **International Civil Aviation Organization** are actively writing new regulations. The results of these pilot programs will dictate the likelihood of drone delivery in 2020 and beyond.

NEAR-FUTURE INVISIBLE HIGHWAYS IN THE SKY

Roy Levkovitz and Amy Webb

Commercial operators like Amazon want to begin drone deliveries. From the Valley to DC, everyone will be talking about whether or not the airspace should be regulated for hobbyists and commercial drone pilots, which will prompt difficult conversations between technologists, researchers, drone manufacturers, businesses and the aviation industry, since each has an economic stake in the future of unmanned vehicles. We anticipate the sky being divided soon: hobbyist pilots will have access to operate UMVs in the 200 and below space, while businesses and commercial pilots will gain exclusive access to 200 - 400 feet zone overhead.

DRONES CONT.

091

Drone Lanes

We're about to have overhead congestion—which means soon, you can expect invisible drone lanes overhead. Amateur drone pilots continue to cause trouble for commercial and private airline pilots. Currently, the **FAA** does not allow drones to fly near the airspace of airports—but while there are no-fly zones, there aren't no-fly circumstances. In **Singapore**, researchers are considering the viability of different options including "air-lanes," the development of "air-blocks" and "air-fences" to manage traffic. **NASA** and the **FAA** are working on initiatives scheduled to end in 2019 and 2025 respectively, which could provide possible nation-wide solutions for managing drone traffic. As sky infrastructure gets designed and developed, look for a potential emerging market for companies in infrastructure management and for AI cloud-based monitoring of the friendly skies.

092

Personal Home Drone Surveillance

Why bother with fixed security cameras when a flying drone could patrol your home? **Sunflower Labs** has developed a home drone surveillance system that includes flying and ground drones—think of them as roving security guards that don't get tired or need bathroom breaks.

093

Sense And Avoid Technology

Robots harnessing neural networks and artificial intelligence can make inferences and decisions when programmed to do so. That's because of **sense and avoid technology**. In 2018, drones will be programmed to navigate along the path of GPS waypoints—and they'll make decisions midair about the best path to take and when to avoid objects like buildings, trees and mountains. Or other drones, for that matter.

094

Microdrones and Drones Used In Dangerous/ Hard-To-Reach Areas

Industries are beginning to utilize smaller, rugged, AI-powered drones to access dangerous and hard-to-reach spaces. Drones are being used to survey the insides of underground mines, ballasts of tanks, and inside nuclear facilities. Home and building inspectors have also begun using drones to inspect rooftops and sides of buildings. Drone adoption for these purposes could result in reducing risk to human life, and cost savings associated with shortened downtimes. **Facebook's** launch of an **internet-providing drone** along with **AT&T's** successful use of a **cellular signal drone** in **Puerto Rico** also highlight additional signals that drones could become a useful and prevalent tool in providing basic services to disparaged areas or locations lacking basic forms of infrastructure.

095

Drone Swarms

Hundreds of micro-drones can be deployed at once and are now capable of moving as one, technological organism in the sky. They're so fast, that cameras have a difficult time capturing them in real-time. This technology was developed by the military, and it's been used for dazzling light shows at **Disney Parks** and during the **Super Bowl** halftime show. Of course, drone swarms aren't always benevolent. Early in 2018, a swarm carrying explosives, said to be controlled by **Syrian rebels**, attacked two **Russian military bases**.

096

Clandestine, Disappearing Drones

In 2016, **DARPA** funded new research in drones capable of making deliveries—and then disappearing into thin air. The agency's **Vanishing Programmable Resources (VAPR)** program has already shown that it's possible to program a small chip to shatter on command. What's coming next is sort of like **Snapchat** for drones.

MID-FUTURE SCENARIO: DRONES AS A SOURCE OF RENEWABLE ENERGY

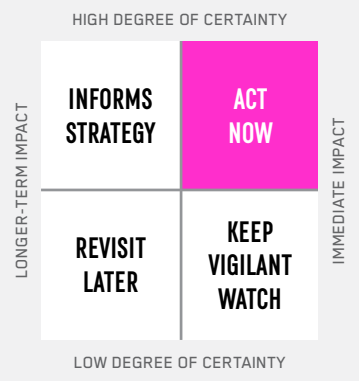
→ Roy Levkovitz

Numerous companies have begun developing drones that will harness wind energy. There are various potential advantages to using drones versus traditional wind turbines. First is mobility: drones can be sent to areas ravaged by natural disasters and provide immediate energy relief. Secondly, drones can fly at higher altitudes than traditional turbines and collect more energy from stronger winds. Finally, drone-based wind collection saves companies from having to install costly towers and foundations.

SECOND YEAR ON THE LIST

CARS

097-106



Key Insight

2018 is the year of the electric vehicle–and it's the year we will see autonomous vehicle prototypes move from car shows to showroom floors. Major automotive giants, including **BMW**, **Audi**, **Ford** and **General Motors**, have announced they'll begin selling AVs within the next three years. If it passes through safety regulators, GM's fourth-generation **Chevy Bolt** may not feature traditional steering wheels and pedals. The initial fleet of AVs is intended for ride-hailing services, which means that **Uber** could be facing competition from the auto manufacturers themselves.

097

Autonomous Testing In Cities Around the U.S.

There's still a considerable amount of real-world testing required before all of our autonomous cars can take to the highways. In 2018, we will see dozens of pilots all around the country as manufacturers test their self-driving vehicles in our communities. **San Francisco** has been a favorite in the past, because its roads offer sudden inclines, dense traffic and fog, while **Arizona** is another popular testing ground because it has long stretches of straight, empty highways. But for AVs to move from the fringe to the mainstream, they'll need to both test and learn under more varied circumstances–blizzards, torrential rain, ice storms, extreme heat and cold, heavy wind. In the near-future, regulators will work to establish a national testing center with a single set of standards and practices. Outside of the U.S., manufacturers in **Sweden**, **Germany**, **Japan** and **China** are rushing to set up their own facilities.

098

Armchair AV Mechanics

Online learning platform **Udacity** launched an open source self-driving car class. It's a four-month program that teaches the essentials of building a self-driving car, and it's part of an engineering "nanodegree" offered by Udacity. Udacity co-founder is **Sebastian Thrun**, who had previously launched **Google's** self-driving car program. The project isn't about increasing competition in the marketplace, but rather about advancing the skills of our future workforce. **MIT** now offers a **Deep Learning for Self-Driving Cars** course, and **Stanford** offers a **Machine Learning for Autonomous Driving** class (both are online and open to the public). While Udacity's program isn't accredited, it does promise to teach all of the skills required to work within the burgeoning field of self-driving vehicles.

099

Assisted Driving Before Full Automation

What drivers will see in new 2019 and 2020 models–lots of assistive features, powered by artificial

CARS CONT.

intelligence. Cameras and sensors will bring more information to heads up displays and smart dashboards, which will enable more assisted driving functions (self-parking, lane departure control, voice controls). But we are still a few more years away from what the **National Highway Transportation and Safety Administration (NHTSA)** calls **Level 4 Full Self-Driving Automation**. Level 4 vehicles are designed to perform all driving functions and monitor roadway conditions for an entire trip—with the driver providing navigation input but not expected to be available for control at any time during the trip. That's because there are external events, such as establishing and funding a new federal agency, or working through licensing and regulations, that could hold up progress for several years. Other events—the availability of components, public attitudes toward autonomous vehicle accidents, and the like—will also impact momentum. We are in transition—the last years of human driving. One thing we are certain of: in the U.S., there will eventually be a new federal agency to address autonomous vehicles, something like a **Federal Autonomous Vehicle Agency (FAVA)**. It will be charged with working alongside the twelve existing agencies concerned with transportation, from highways to aviation.

100

Adaptive Driving Systems

Motorcycle injuries have increased in the past few years, and the reason has to do with age. Nationwide, 39% of motorcycle owners are 51 to 69, according to the **Motorcycle Industry Council**, and at that age reaction time is slower than optimal. **Yamaha's Motobot** is designed with an aging population in mind: Yamaha has partnered with **SRI International** to create a motorcycle that can drive on its own. The technology being developed will eventually be used to help assist motorcyclists on the road—when they're not able to act fast enough, the system will take over. Adaptive systems, which help drivers stay in their lanes, prevent them from driving too closely to another car, and parallel park, will be deployed into new vehicles in 2018.

101

Vehicle-to-Vehicle (V2V) Communications

Cars are able to broadcast their exact positions, speed, acceleration, steering wheel position, momentum, brake status and a host of other information to all of the other vehicles sharing a road within a set distance. Collectively, the cars use this information and analyze it in real-time, to make decisions about how and when to move. Building a V2V network does pose a challenge: it would need to be unfailingly reliable, fast and secure. Some cars equipped with transmitters will be on the road in 2018.

102

Electric Vehicles

Electric vehicles (EVs) are mechanically simpler than their internal combustion cousins—they're cost effective, too. Drivers tend to save 36%—about $11,000 over 10 years—compared to those driving gas-powered cars. **U.S. Speaker of the House Paul Ryan** once called electric vehicle (EV) tax credits "money wasted on losers," but the $7,500 EV tax credit survived the final tax bill Congress signed at the end of 2017. (For those keeping track, we're up to $17k in savings.) **General Motors** is launching 20 new EV models by 2023, while **BMW**, **Nissan**, **Jaguar**, **Porsche**, **Audi**, **Volkswagen**, **Volvo** and **Tesla** will all have EVs out in 2018. As a result, we should see more charging stations throughout communities everywhere. **Kansas City Power & Light** is installing 1,000 charging stations throughout Kansas City and more rural areas in eastern Kansas and western Missouri, while drivers in **San Diego** and **Seattle** will find dense clusters of charging stations all throughout their cities. 2018 is the year of the EV.

103

Cars as Interfaces

Modern cars double as communication platforms, connecting us to our digital assistants (**Amazon's Alexa**, **Google**, **Apple's Siri**, **Microsoft's Sync** and **Cortana**), entertainment systems (**Spotify**, **TuneIn**, **Slacker Radio**), and even our internet service providers (many cars are their own WiFi hotspots). Soon, cars will connect to each other in V2V networks—and they will connect back to city hubs and transportation infrastructure. As a result, digital and autonomous user interface design will play a key role in auto manufacturing going forward—which means new partnerships between our technology providers, startups and traditional car manufacturers.

104

Solar Highways

Researchers have been working on roads capable of producing their own energy. Think of them as smart, modular systems that can illuminate lines and markings, keep ice melted, generate electricity for EV power stations, and even communicate data about whether any section of the road needs repair. In **Jian, China**, a new photovoltaic highway has already opened, joining **France** and the **Netherlands**. In **Poland**, city planners are experimenting with solar-powered, glow-in-the-dark bike lanes. In the U.S., Idaho-based **Solar Roadways** has a number of pilot projects in the works, including a solar sidewalk in **Baltimore's Inner Harbor** and a portion of the **Route 66** highway as part of **Missouri's Road to Tomorrow** initiative. Made from **luminophores**, which are made of small phosphor crystals, they absorb sunlight during the day and illuminates a brilliant blue at night.

105

Autonomous Vehicle Legislation

In 2018, U.S. policymakers will debate whether AV companies should be required to still offer features that allow humans to take control in case cars fail. As **General Motors** and **Alphabet's Waymo** join **Tesla** in launching AVs with more autonomous capabilities, federal legislation would be required to make the cars street legal across state lines. As of now, not every state allows AVs to be operated.

106

Flying Cars

Though we're likely to see new flying car prototypes in 2018 and 2019, it's unlikely we'll see true flying cars overhead anytime soon. Even so, **Alphabet** co-founder **Larry Page** has built a not-so-secret flying car factory, breathing new hope into a very old tech myth. Flying cars have been a persistent, trendy theme within popular culture on and off for more than a hundred years. **Waldo Waterman's Arrowbile** was the first to leave the street for the sky in 1937. Three years later, **Henry Ford** remarked confidently, "Mark my word: a combination airplane and motorcar is coming." Aviation publicist **Harry Bruno** clarified, saying that cars of the future would look like tiny "copters"; when school let out, they would "fill the sky as the bicycles of our youth filled the prewar roads." In 1949 Life magazine featured the **Airphibian**, an aerocar that could fly from a backyard airstrip to **LaGuardia Airport** and then transform into a convertible-like vehicle capable of driving to **Times Square**. The dream of flying cars continued into the twenty-first century and up to the present day as people built new prototypes with vertical take-off and landing capabilities, super-strong carbon fiber bodies, ducted fan propulsion, and cheaper flight-stabilizing computer systems.

FUTURE OF CARS: SCENARIOS FOR 2018 - 2048

Given what we know to be true as of the date of publication, here are just a few plausible scenarios for the next few decades.

→ Future Today Institute Research Team

THIS YEAR

By the end of 2018, cars will be equipped with software updates and new sensors that perform more functions for the driver, such as parking and adaptive cruise control. In the U.S., Congress will fail to pass federal legislation allowing cars without traditional steering wheels and foot pedals.

NEAR-TERM: 1 - 5 YEARS

New cars will be equipped with cross-path cameras to sense nearby objects and they will have adaptive cruise control for driving in stop-and-go traffic. They will offer many driverless functions—but humans will still be in the loop, operate the car in neighborhoods and many city streets. Fully autonomous taxi services will begin testing—we'll hail them and pay for our rides with our smartphones.

MID-RANGE: 5 - 10 YEARS

Advanced Lidar and WiFi technology will transmit your vehicle's location and will recognize other vehicles sharing the road. This will begin to enable cars to drive themselves on highways and many city streets.

LONG-RANGE: 10 - 20 YEARS

The highway system, which has long stretches of solar cells, will have been upgraded to work in symbiosis with semi-autonomous vehicles. Highways will create power for AV charging stations. On mandated autonomous highway lanes, people will be free to read, watch videos or conduct work. Human drivers will take over on smaller streets. However extreme weather events will increase. Because AV manufacturers didn't hire climate scientists to be a part of the design and programming team, our cars act in weird and unexpected ways during intense heat and cold spells, sudden wildfires, blizzards, heavy rain and strong winds. With more EVs drawing power from the grid, utility companies that failed to plan ahead buckle under heavy use, especially in the summer.

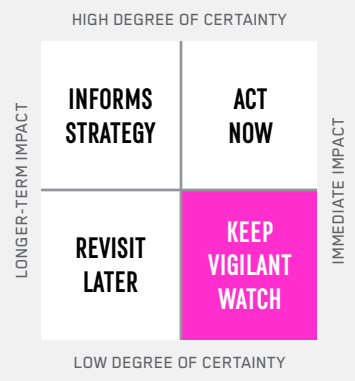
FAR-RANGE: 20 - 30 YEARS

Climate and electricity issues will have been worked through—but not before a few horrific incidents, which spurred new regulations and caused us to question whether it was a good idea to fully surrender ourselves to machines. We will no longer own cars and cities will no longer operate transit systems. Instead, automated buses will be subsidized through taxes and will be offered at no cost. Those with the means to do so will subscribe to a transportation service, which operates vehicles that are fully automated and will transport us to destinations as required.

FIRST YEAR ON THE LIST

Supersonic Flights

107



Boom Technologies is developing a supersonic jet.

Key Insight

A number of companies are bringing back supersonic jet travel.

Examples

After years of successful Trans-Atlantic flights, the age of supersonic jet travel came to an end in October 2003, when **British Airways** permanently grounded the **Concorde**. Driven in part by the enthusiasm and excitement over faster, autonomous travel, supersonic jets are being tested once again.

What's Next

Japan Airlines (JAL) has invested $10 million in **Boom Technology** to develop supersonic jets, which will travel at 2.2 times the speed of sound–about twice as fast as a traditional aircraft. (JAL has already pre-ordered 20.) **All Nippon Airlines** is similarly researching supersonic flight. **Aerion**, **Lockheed Martin** and **GE Aviation** are developing a supersonic business jet that could carry 12 passengers. For those who remember the loud crashing sound made by the Concorde, **NASA** and Lockheed Martin have been developing new ways to muffle sonic booms. Flights are already being scheduled for 2023.

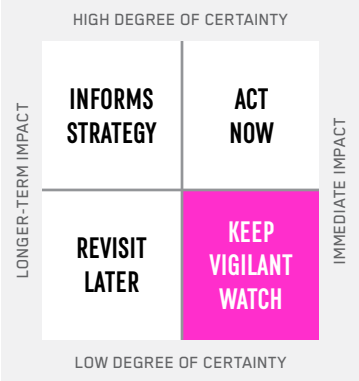
Watchlist

Japan Airlines; All Nippon Airlines; Aerion; Lockheed Martin; GE Aviation; Boeing; NASA.

FIRST YEAR ON THE LIST

Autonomous Ships

108



The Yara Birkeland is an autonomous container ship.

Key Insight

We've built autonomous cars—next up, large ships that captain themselves.

Examples

Electric-powered ships that don't require a human crew will take its first voyage in 2018. The Yara Birkeland is an autonomous container ship which is supported by radar, LiDAR, machine learning and computer vision systems, an automatic mooring system and a network for cameras. And, if all goes well, it won't require humans at the dock—loading and unloading will be done automatically using computers and electric equipment.

What's Next

Early 2018, an oil tanker caught fire after colliding with another boat in the **East China Sea**, killing more than two dozen people. It's another reason that companies are looking to automation in shipping. The Yara is one of several projects in the works, and it will still take a few years and several test runs before starting fully autonomous operations. At the moment, it costs far more to build and operate an autonomous ship than a traditional one—but the longer-term benefits are already clear. Electric ships that don't require people would offer a massive cost savings throughout the entire shipping supply chain. They'd be safer, would solve for labor shortages and would be better for the environment.

Watchlist

NOAA; Kongsberg; Marin Teknikk; ENOVA.

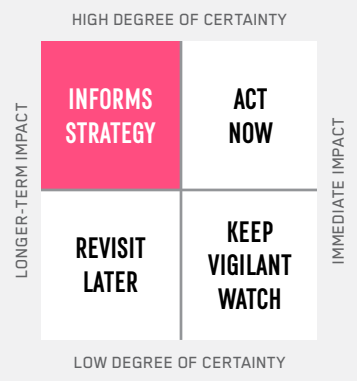
NEWS MEDIA, BOOK PUBLISHING, SOCIAL NETWORKS AND THE FIRST AMENDMENT

109 Natural Language Generation for Reading Levels
110 Computational Photography
111 Computational Journalism
112 I-Teams For Algorithms and Data
113 Voice Interfaces For News and Books
114 Proximity News
115 Crowdlearning
116 Digital Frailty
117 Radical Transparency
118 Limited-Edition News Products
119 One-To-Few Publishing
120 Notification Layer (A Tragedy of the Commons)
121 Journalism as a Service (JaaS)
122 Transparency in Metrics
123 Real-Time Fact Checking
124 Offline Is The New Online
125 Audio Search Engines
126 Synthetic Data Sets
127 Connected TVs
128 Decentralizing The Web
129 Streaming Social Video
130 New Video and Audio Story Formats
131 Media Consolidation
132 Social Tweaks To Social Network Algorithms
133 The First Amendment in a Digital Age

THIRD YEAR ON THE LIST

Natural Language Generation for Reading Levels

109



University of Washington developed an NLG model that convincingly showed President Barack Obama giving a speech that he never actually gave in real life.

Key Insight

Natural Language Generation (NLG) is a processing task, where computers generate the kind of language humans would use in a designated situation. NLG can be used to rewrite content for a variety of different reading levels.

Examples

Many companies–including **Credit Suisse**, **Deloitte**, and a number of news organizations–were already using **Narrative Science**, an NLG provider. A basic set of data was processed with an NLG algorithm to produce a readable story, which sounded no different than if a human had written it. In 2017, researchers at the **University of Washington** developed an NLG model that convincingly showed President Barack Obama giving a speech–that he never actually gave in real life.

What's Next

As **book publishers** and **news organizations** search for new revenue streams, NLG will be used not just to write stories–but to create different versions for audiences with varying reading skills. That's because the basic corpus–the data that makes up the story–wouldn't change, but the vocabulary and amount of detail could be adjusted. For example, a single story about the results of **Berkshire Hathaway's** quarterly earnings could be rendered in many different ways: for finance professionals, for high school economics classes, for beginning English as a second language learners, and for MBA students in non-English speaking countries. Similarly, NLG could be used to automate the current work-intensive process to create book extracts and summaries. Using NLG to custom-write different versions of stories, enables organizations to scale their operations for new audiences worldwide–without hiring additional staff. But NLG can also be used to create hyper-realistic fake news videos–something to be on the lookout for in 2018.

Watchlist

MIT-CSAIL; Arria NLG; Narrative Science; Expect Labs; Automated Insights; Department of Computing Science, University of Aberdeen; School of Science and Engineering, University of Dundee; Research Center on Information Technologies (CiTIUS), University of Santiago de Compostela, Spain; School of Informatics University of Edinburgh.

FOURTH YEAR ON THE LIST

Computational Photography

110

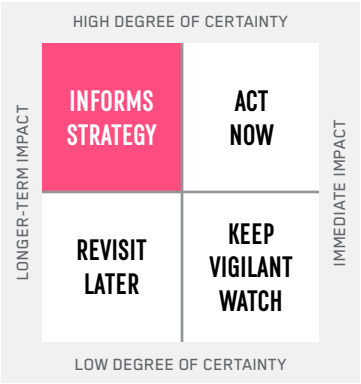


Image Credit: UCSB Mirage Lab

The Computational Zoom system makes it possible to automatically combine wide-angle and telephoto perspectives into a single multi-perspective image.

Key Insight

Computational photography is the convergence of computer vision, computer graphics, the internet and photography. Rather than relying on optical processes alone, it uses digital capturing and processing techniques to capture real life.

Examples

Everyone with a smartphone now has access to computational photography tools. In its **iPhone 8** and **iPhone X**, **Apple** uses computational photography to achieve a shallow depth of field, while **Facebook** automagically corrects any 360-degree photos you upload.

What's Next

New research from **Nvidia** and the **University of California-Santa Barbara** reveal a computational zoom technique, which allows photographers to change the composition of their photographs in real time. Photos are taken in a stack, and then rendered with multiple views. This would allow photographers to change perspective and the relative size of objects within a photo after it has been taken. Other use cases of computational photography include seamlessly removing or adding objects to scenes, changing shadows and reflections, and the like. Meanwhile, **MIT's CSAIL** and **Alphabet** developed a technique that now automatically retouches and enhances the photos we take with our mobile phones. Clearly there are ethical implications here for journalists—how much editing should be allowed and under what circumstances? Likewise, journalists should develop techniques to reveal how much editing has been done to a photo—either intentionally or automatically—before using them for reporting or in stories.

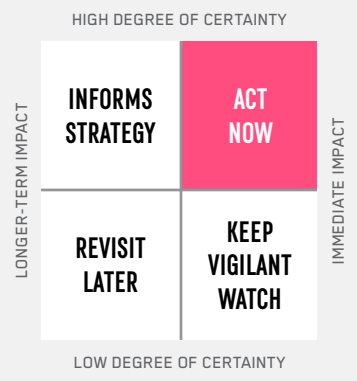
Watchlist

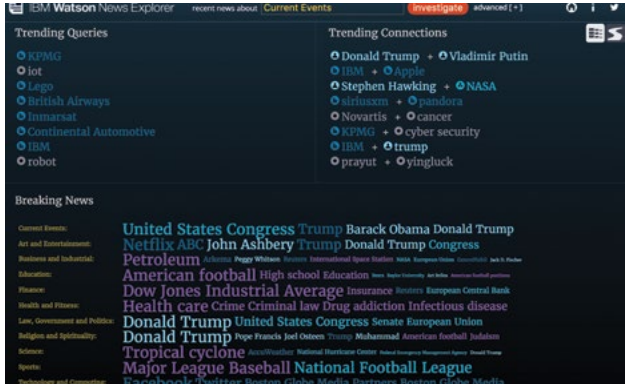
MIT's CSAIL; MIT's Media Lab; Nvidia; University of California-Santa Barbara; Google; Apple; Samsung; Facebook; Synopsys; Industrial Light and Magic; LG; Huawei; Morpho; Qualcomm; Stanford University Computational Imaging Lab; the Gcam team at Google Research.

FOURTH YEAR ON THE LIST

Computational Journalism

111





IBM's News Explorer is an example of a computational system for reporting.

Key Insight

What are the ways in which data and algorithms can enhance reporting? **Computer Assisted Reporting** (or **CAR**, as its known by industry professionals) is an investigative journalism technique. Reporters find, clean and mine public records and documents, crunch data and uncover hidden stories. Aided by machine learning algorithms and AI, computational journalism is the evolution of CAR.

Examples

It's one thing to find and mine public data—analyzing what's there, and connecting the seemingly unconnectable dots, is another challenge entirely. Computational journalism techniques such as multi-language indexing, automated reporting, entity extraction, algorithmic visualization, multidimensional analysis of data sets, flexible data scraping, are allowing journalists to combine what they find in the data and then see the connections between facts, keywords and concepts. In this way, they can reveal interconnected relationships between people and organizations that they might not have otherwise seen.

What's Next

We anticipate increased demand in computational journalism and journalists with complimentary skills sets. There are a host of stories waiting to be discovered, written and produced.

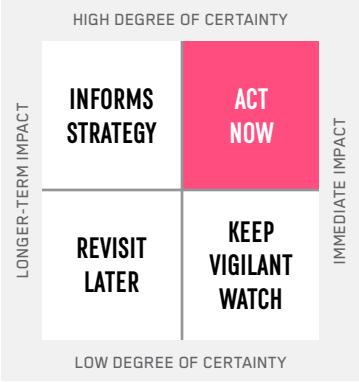
Watchlist

Investigative Reporters & Editors; National Institute for Computer-Assisted Reporting; Coral Project; Stanford Computational Journalism Lab; Duke University; University of British Columbia; University of Texas at Austin; Brown Institute at Columbia University; Tow Center for Digital Journalism at Columbia University; Philip Merrill College of Journalism at the University of Maryland; Media Change and Innovation Division at the University of Zurich; Annenberg School of Communication & Journalism and the University of Southern California; Wall Street Journal; New York Times; Washington Post; Tamedia; ProPublica; National Public Radio.

FOURTH YEAR ON THE LIST

I-Teams For Algorithms and Data

112



AI systems rely on our trust.

Key Insight

News organizations need a new kind of special-ops team: investigative reporters who specialize in investigating the algorithms and data itself.

Examples

Algorithms, data sets and AI systems reflect the worldviews of their architects and trainers. This information is used to help make decisions, to predict behavior, and to generate answers to questions. More of these systems now govern everyday life and are used by law enforcement, universities, financial institutions and government agencies. Journalists must begin to investigate how the data and algorithms intersect with daily life. And, to prevent bias in reporting, journalists must gain a better understanding of who created the algorithms and data sets, and what their processes were. For example, the **PredPol** predictive policing system, which is used by police departments around the U.S., recommended time and time again that departments concentrate their efforts on neighborhoods that were overwhelmingly poor and black. The problem has to do with how arrest data is gathered, and how individual police departments have historically monitored their local communities. The model didn't include a rigorous check on bias in the initial data sets. Reporters at the **New York Times**, **Wall Street Journal**, **ProPublic**a and **Washington Post** have been applying the core practices and skills of reporting to investigating algorithms.

What's Next

We will soon reach a point when we will no longer be able to tell if a data set has been tampered with, either intentionally or accidentally. AI systems rely on our trust. If we no longer trust the outcome, decades of research and technological advancement will be for naught. Building trust and accountability is a matter of showing the work performed. This is a complicated process, as understandably news organizations would want to keep certain data and reporting methods private.

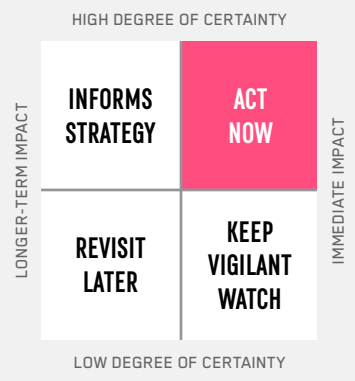
Watchlist

Brown Institute at Columbia University; Macromedia University of Applied Sciences; Tow Center for Digital Journalism at Columbia University; AlgorithmWatch.org; ProPublica; Philip Merrill College of Journalism at the University of Maryland; Media Change and Innovation Division at the University of Zurich; Annenberg School of Communication & Journalism and the University of Southern California; Washington Post; New York Times; Wall Street Journal; National Public Radio; Investigative Reporters & Editors; National Institute for Computer-Assisted Reporting.

SIXTH YEAR ON THE LIST

Voice Interfaces For News and Books

113



Amazon's Echo is an voice interface found in many American homes.

Key Insight

We are entering an era of conversational interfaces. You can be expected to talk to machines for the rest of your life. These systems use semantic and natural language processing, along with our data, in order to anticipate what we want or need to do next.

Examples

If you've ever used **Siri**, **Google Now**, **Amazon's Alexa** or even the microphone button on your **Comcast** remote control, you're familiar with voice interfaces. Soon, you will find yourself talking to a host of connected devices, such as your home thermostat, your car, your refrigerator, your earbuds, even your connected water bottle. By 2023, 50% of the interactions North Americans have with machines will be using their voices.

Conversational interfaces can simulate the conversations that a reporter might have with her editor, as she talks through the facts of a story. **IBM Watson's** various APIs, including **Visual Recognition**, **AlchemyLanguage**, **Conversation** and **Tone Analyzer** can all be used to assist reporters with their work.

What's Next

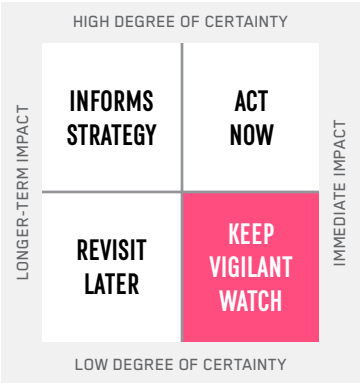
Amazon's Alexa is quickly rising to become the default platform for voice, with thousands of companies now integrating Alexa with their own products and services. That includes an unusual collaboration with **Microsoft**, whose **Cortana** now opens Alexa. Meantime, there is emerging research into using voice interfaces to help professionals understand different sides of an argument. IBM recently built a prototype that allows the user to ask a question–such as "do violent video games contribute to violent acts in the real world"–and receive a spoken analysis. A system like this could one day be an invaluable newsroom tool, allowing reporters to hash out their reporting and analysis with a smart machine via a conversational interface.

Watchlist

Amazon; Alphabet; IBM Research; Cognitive Horizons Network; Stanford University; MIT CSAIL; MIT Media Lab; University of Texas at Austin; Apple; Microsoft.

SIXTH YEAR ON THE LIST

Proximity News



Proximity networks are being built for content distribution.

114

Key Insight

New technologies can be programmed to push or receive information to/ from our mobile devices–and also our bodies–tethering us to an always-on ubiquitous information network.

Examples

You've no doubt heard about **beacons**, which are tiny devices that can be programmed to push (or receive) information to/from mobile phones using **Bluetooth**. They are located on nearby networks, as sensors use our personal information and collect data about our experiences. Beacons become aware once you're near them. They're used frequently for marketing, however they can also be used during planned news/ culture/ arts/ sports events and throughout cities to share news content with nearby people. Think of it as proximity news.

What's Next

Apple's Safari Technology release (#38) enabled the **Beacon API** by default and turned on Beacon features for **iOS** devices. Soon, we will be able to deliver proximity-based news via WiFi, which can now identify you just by bouncing signals around–your unique shape and posture are used to reveal who you are, even in a crowded room of people. Emerging research has shown that WiFi can be used to recognize what a person is saying or writing with a pen–simply by analyzing the WiFi signals altered by our bodies. In a confined space, like a conference center, sporting arena or airport, this would allow a news organization to recognize one of its news consumers and deliver stories just for her.

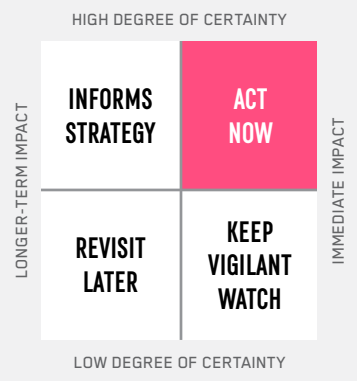
Watchlist

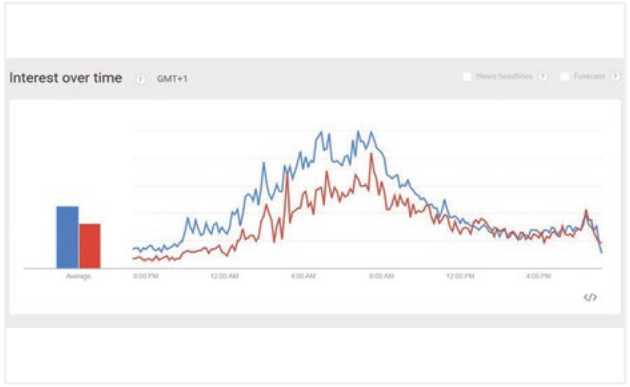
Google's Eddystone platform; Apple's iBeacon platform; IndoorAtlas; Unacast; Facebook; Blis; Snapchat; Polytechnical University (China); MIT; University of New South Wales (Australia); Oxford University; BLIP Systems; Bluedot; Gimbal; Qualcomm; Intel; Amazon.

THIRD YEAR ON THE LIST

Crowdlearning

115





Searches for "what is the eu" and "what is brexit" surged after the U.K. election.

Key Insight

You're familiar with **crowdsourcing**: asking the public to contribute content or to assist with on-the-ground reporting on an issue. **Crowdlearning** is a computational journalism technique that queries our passive data—our mobile and online activity, our public health records, our locations—to learn or understand something new.

Examples

In June 2016, the evening after citizens in the **United Kingdom** voted for **Brexit**, Google revealed sobering search data: people in the UK were Googling "what is the EU." This passive data told an interesting story, and it's just part of what we're now able to learn from the crowd by monitoring various networks. Our smartphone ownership has reached critical mass, and so has our use of various networks. Our data not only follows us around, it's often available for anyone to search, collect and analyze.

What's Next

Good crowdlearning sources are already available to us, and they include **HealthData.gov, Google's** busy times data for businesses and public spaces, **Waze**, **Wikipedia** and more. We anticipate that more news organizations—as well as marketers, activists and other groups—will start harnessing data in creative ways. That's because our thinking results in behavior (like searching for "what is the EU?"). Our behavior results in data. And that data can be used to learn something about us.

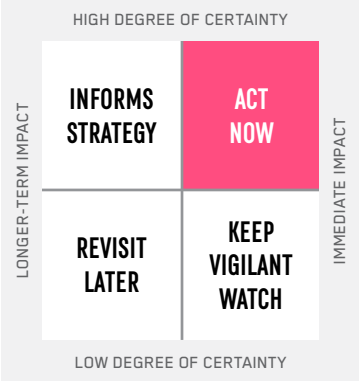
Watchlist

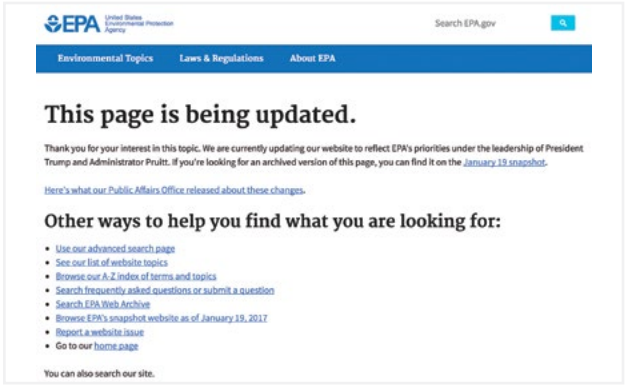
Google; Bing; Apple; Microsoft; Investigative Reporters and Editors; National Institute for Computer-Assisted Reporting; various U.S. government websites; various state and local government websites; the websites of government agencies worldwide.

THIRD YEAR ON THE LIST

Digital Frailty

116





A screenshot of the U.S. Environmental Protection Agency's website taken on September 6, 2017.

Key Insight

In the past three years, we've seen the first widespread cases of important journalism being erased from the web because of media consolidation or because sites were no longer being maintained. **Digital Frailty** is the phenomenon in which those digital assets published to a news organization's website are impermanent or easily broken.

Examples

Perhaps not every **Facebook** post should be saved in perpetuity, but might we need to look back on this moment in time and reflect on how our language–how the very way we communicate–was shaped by our **Instas**, our **Snaps**, and our tweets? Will our future historians look back, marveling at the amount of anthropological data we were simultaneously creating–and destroying? If this past election season taught us anything, it's that **Twitter** helped to shape public opinion and the outcome of the election, even as many controversial tweets posted by candidates running for office, were deleted by their campaigns.

A Pulitzer Prize-winning investigative series about a collision that killed 20 children and devastated a Colorado community went offline when the **Rocky Mountain News** went out of business. **The Tampa Tribune**, whose motto was "Life. Printed Daily," kept its rival, The Tribune, hunting for important stories in the public interest, covering investigations into Tampa's judges, legislators and law enforcement.

Humanity operates on a continuum. After devastating Texas, Hurricane Harvey made landfall near New Orleans on the 12th anniversary of Katrina. **Rising From Ruin**, an award-winning project by **MSNBC**, told the Katrina's aftermath through the lenses of two small communities in Mississippi that weren't covered by any other media outlet. It included a series of videos, maps, interactive elements, a forum for residents–and since it only existed as a website, there was no other way to see the stories. When **Microsoft** pulled out of its joint venture with **NBC**, the project went offline.

Digital Frailty in Government and Public Information

American journalists watched as **U.S. government agencies** removed studies, data and reports throughout 2016, 2017 and 2018. Most notably, the **Environmental Protection Agency** scrubbed its website of climate change information. This was an effort to support the **Trump Administration's** ideas and policies. A government website built to educate children, called "Energy Kids," also scrubbed mentions of climate change. The Trump Administration also removed LGBTQ content from federal websites, scrubbed a lot of civil rights information off of **WhiteHouse.gov** and scrubbed the **HHS.gov** website of healthcare data. Federal agencies instructed staff and grant recipients to avoid using certain phrases–"transgender," "fetus," "science-based," "evidence-based,"–citing concerns by the Trump Administration.

DIGITAL FRAILTY CONT.

What's Next

Digital frailty is a phenomenon affecting journalists everywhere. Digital frailty isn't just about falling revenue—sometimes, new technology obviates the old, before anyone's had a chance to convert files or develop archives. News executive **Mario Tedeschini-Lalli** explains how Italy's largest news website, Repubblica.it, didn't originally use a content management system. When the site installed a CMS for the first time, everything published before it was lost forever. Tedeschini-Lalli, along with colleagues **Nicolas Kayser-Bril**, **Anne-Lise Bouyer**, **Pierre Romera** and **Defne Altiok**, launched the **Offshore Journalism Project**—they hope to preserve national and private archives and ensure that quality journalism lives on, even if political appointees and governments disagree. While some content can be retrieved via the **Internet Archive**, it is only taking snapshots of content at a time. Libraries archive printed material, but there is no central repository for all of the digital content we are now producing. Perhaps we don't need to save every listicle and quiz. What will a future society look like if our current media landscape goes dark? Do we have an obligation to preserve the digital conversations shaping society? Should we be working harder to ensure that digital archives aren't lost?

Watchlist

Axel Springer; Yahoo; Tumblr; Hearst Corporation; Time Inc; Yomiuri Shimbun Holdings; Tronc; Gannett; Viacom; Hubert Burda Media; Comcast; Alphabet; Asahi Shimbun Company; Microsoft; Grupo Globo; Advance Publications; News Corp; Univision; Baidu; Bertelsmann; Twitter; Snap; Instagram; General Electric; Bloomberg; Disney; Amazon; AT&T; Verizon; ESPN; Netflix; Hulu; The Onion; PRX; PRI; Internet Archive; news organizations everywhere.

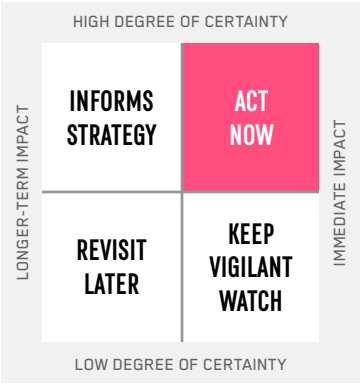
"We're not at war with the administration, we're at work. We're doing our jobs."

– Marty Baron, Editor of the Washington Post

THIRD YEAR ON THE LIST

Radical Transparency

117



In this age of technology, we need a nutritional label for news.

Key Insight

In the past year, credible news organizations have faced a crisis of confidence caused by **Twitter** bots, political extremists, and elected officials. Radical transparency offers the public a full view of how the story was reported and produced.

Examples

There are too many instances of "fake news" accusations to list. In order for journalists to combat a growing, but unfounded, public distrust, they should offer radically transparent reporting. **PolitiFact**, the Pulitzer Prize-winning fact-checking website, lists all of the sources used for a story. **ProPublica's / nerds blog** explains some of the work behind data journalists, developers and reporters' stories.

What's Next

Professor Ahmed Elgammal at **Rutgers University** developed an algorithm that looks for novelty in paintings and analyzes which artists influenced that work. His research has inspired others to use similar network analysis, historical data and machine learning to look for similarities in literature, writing and news. A system like this could be deployed to look for explicit and hidden influencers on news stories. Now that news organizations are relying on data, algorithms, and machine learning for various aspects of news gathering and publishing, they should commit to radical transparency. There are too many instances of bias in algorithms to list. Just as consumers expect to see a byline on stories, because it creates a chain of accountability, they will soon expect to know how stories were built. Reporters aided and augmented by smart systems should explain what data sets and tools they used. Meanwhile, stories that were written in part or entirely by computers should reflect that an algorithm was responsible for the piece of content being read/watched.

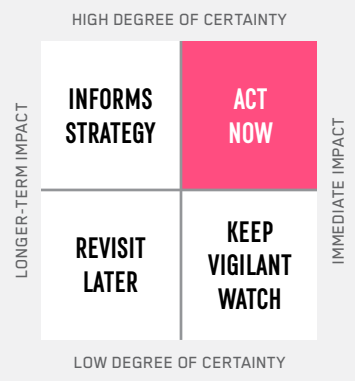
Watchlist

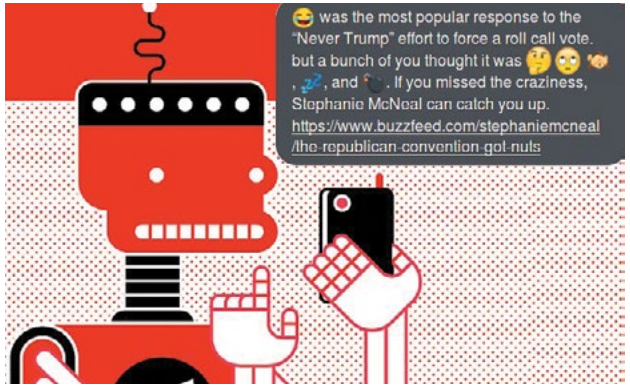
News organizations everywhere.

FOURTH YEAR ON THE LIST

Limited-Edition News Products

118





BuzzFeed's BuzzBot was active during the 2016 Republican National Convention.

Key Insight

Some organizations have begun to experiment with temporary products: limited-run newsletters, podcasts that only last a set number of episodes, live SMS offerings that happen only during events.

Examples

News organizations creating limited-edition news products, do not necessarily need to create many labor-intensive, one-off templates and workflows. Producers can develop templates that can be iterated on and redeployed again. **BuzzFeed** stood up a temporary chatbot during the political conventions in 2016, while the **New York Times** launched a short-term chat service for the Olympics.

Whether it's a planned news event (such as local elections, festivals or races), an annual conference (**ONA**, **SXSW**, **PopTech**), a season (skiing, football, baseball), or a big story that has a defined beginning middle and end (such as a weather event), limited-edition news products are starting to be used by news organizations.

What's Next

We anticipate seeing more temporary podcasts, newsletters and chatbots that are deployed specifically for just one event. Limited-edition news products are revenue and audience engagement opportunities, as they are vehicles for data collection and targeted advertising.

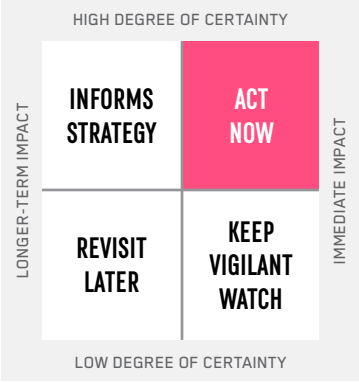
Watchlist

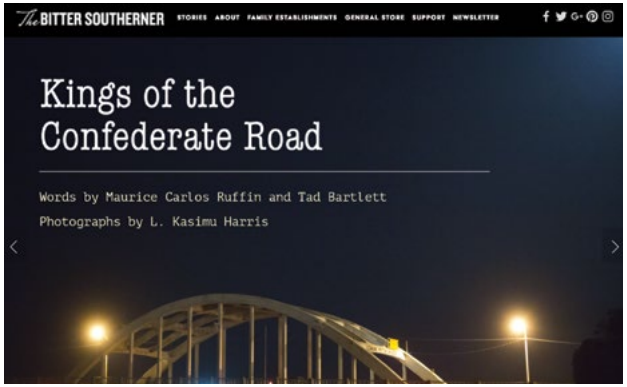
News organizations everywhere.

FOURTH YEAR ON THE LIST

One-To-Few Publishing

119





The Bitter Southerner is a new breed of website with a highly engaged niche audience that pays for content.

Key Insight

Newsletters, podcasts and niche networks that captivate smaller audiences made a huge comeback between 2015-17. What's next is an expansion to capture even more niche audiences.

Examples

Suddenly, it seems like everyone—from world leaders, to your next-door neighbor—has a podcast, newsletter, a chatbot or all three. This is due in part to services like **Mailchimp**, **TinyLetter** (owned by **Mailchimp, and being folded into the Mailchimp platform entirely this year**), **Skype**, **Google Hangouts**, **Garage Band**, **SoundCloud**, **Libsyn**, **Stitcher**, **Auphonic**, **SpeakPipe** and a host of affordable smartphone microphone attachments. In 2017, we watched new niche media empires take root: **Jessica Lessin's The Information** publishes in-depth stories on tech and business. Former MTV chief digital officer **Jason Hirschhorn** expanded his **REDEF** newsletter empire.

What's Next

We anticipate seeing more and more niche networks launch, whether they are individual newsletters or podcasts. We also expect to see more niche-focused digital-only content products—private content networks, short-form podcasts, and augmented reality integrations—in 2018 and 2019. Smaller sites like, **Nautil.us**, **Pacific Standard**, **Bitter Southerner**, **New Inquiry** and **Aeon** produce exceptional content and command very attentive audiences. Our research shows that there is profit to be made, even though audiences may be smaller in size. As many of the one-to-few startups have proven in the past 24 months, an influential network with sticky engagement shows why dedicated attention matters more than a bunch of clicks, and that's the metric that will matter most in the near future. Advertisers are taking notice.

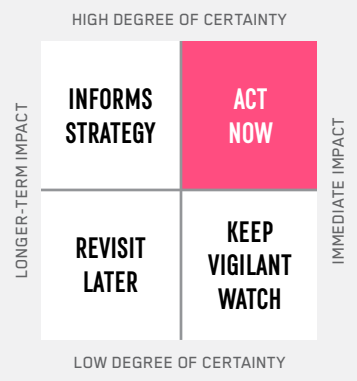
Watchlist

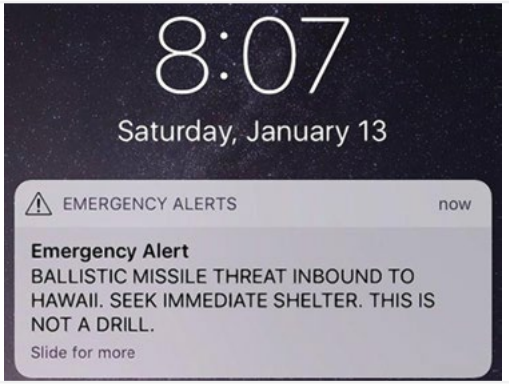
REDEF Group; The Information; PRX; TinyLetter; Mailchimp; Nautilus; Pacific Standard; Bitter Southerner; New Inquiry; Aeon; Backchannel; Skype; Garage Band; SoundCloud; Libsyn; Stitcher; Auphonic; SpeakPipe; Twilio; PRI; RadioPublic.

THIRD YEAR ON THE LIST

Notification Layer (A Tragedy of the Commons)

120





In January 2018, Hawaii emergency response accidentally sent out a ballistic missile alarm notification.

Key Insight

Notifications show bits of information, including updates, reminders and messages from friends. They appear on the lock screens of mobile phones, wearables and connected devices.

Examples

Notifications are particularly attractive to news organizations because they capture attention when our attention is most vulnerable. Leveraging our FOMO, notifications tempt us to look at our screens and to click through. Users who opt-in to receive push notifications increase app retention rates by 2x or more, while opt-in users are twice as likely to engage with the content teased. Most major news organizations, as well as content-creators from other sectors, are now engaging notifications to pull users into content.

What's Next

The problem is that notifications now come from everywhere–from the OS, government emergency services, weather apps, games, social networks, podcasts, and more. Notifications with photos and emoji perform better, which is a show of how cluttered the space has become. News organizations will need to develop new tactics and strategies to ensure that their notifications don't add to the existing notification layer of clutter–and so they do not alienate readers.

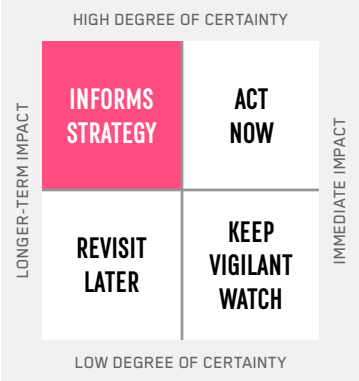
Watchlist

News organizations everywhere; Android; Apple; Amazon; Microsoft.

FOURTH YEAR ON THE LIST

Journalism as a Service (JaaS)

121



News organizations will find new ways to generate revenue through Journalism as a Service.

Key Insight

On the fringes, news organizations are beginning to provide journalism as a service, rather than traditional news products.

Examples

"Software as a Service" is a licensing and delivery model, where users pay for on-demand access. It's a model that in the near-future might be an inevitability. The central challenge within news organizations is that there are immediate, acute problems–but reasonable solutions will require long-term investment in energy and capital. The tension between the two always results in short-term fixes, like swapping out micro-paywalls for site-wide paywalls. In a sense, this is analogous to making interest-only payments on a loan, without paying down the principal. Failing to pay down the principal means that debt–that problem–sticks around longer. It doesn't ever go away. Transitioning to "Journalism as a Service" enables news organizations to fully realize their value to everyone working in the knowledge economy–universities, legal startups, data science companies, businesses, hospitals, and even big tech giants. News organizations that archive their content are sitting on an enormous corpus–data that can be structured, cleaned and used by numerous other groups.

What's Next

News deployed as a service includes different kinds of parcels: news stories; APIs; databases that can be used by both the newsroom and paying third parties; calendar plug-ins for upcoming news events; systems that can automatically generate reports using the news org's archives and databases and the like. Services work outside of the social media landscape, relieving news organizations of revenue sharing and allowing them to fully monetize their services.

Watchlist

PRX; Twilio; REDEF Group; The Information; The Coral Project; MIT Media Lab; ProPublica.

SECOND YEAR ON THE LIST

Transparency in Metrics

122

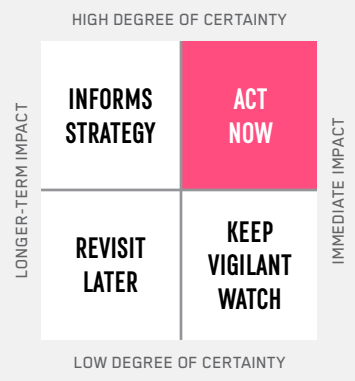


Photo Credit: http://www.adoraattack.com/fuzzy-numbers/

Historically, news organizations have kept audience data hidden from staff, while third-party services haven't always been transparent about what numbers they're counting.

Key Insight

Social networks are under pressure to offer more transparency in the numbers they report back to news organizations. While most companies that publish content on the web are obsessed with metrics, historically they've kept audience data hidden from staff.

Examples

Metrics are neither easy to find nor easy to understand for many working inside of content organizations. In 2016, **Facebook** apologized for displaying incorrect numbers of video plays to advertisers and publishers, and said that it had been showing incorrect metrics for two years as it attempted to challenge **YouTube**. Earlier in the year, current and former Facebook staff alleged they were instructed to suppress conservative news from the site's **"Trending Topics"** area. During the summer of 2017, Facebook offered new landing page views and page interaction metrics, which the company said would offer better insights for advertisers.

It goes without saying that metrics can influence editorial and business decisions, not to mention how the public interprets the popularity of a story. Most large news organizations have hired audience engagement and analytics managers as go-betweens.

What's Next

Now that **Facebook** has announced it's weighing personal posts over news stories from publishers, and **Google** is launching a native ad-blocking client in **Chrome**, everyone in the digital marketing and advertising space is wondering what's next for metrics. Already, publishers and advertisers will question the validity of metrics that they, themselves, cannot verify. Anyone creating content needs to understand the ebb and flow of traffic and how one piece of content fits into the broader scope of the organization. We also expect to see news and other content as organizations develop new models to bring transparency in metrics to staff—without jeopardizing editorial integrity.

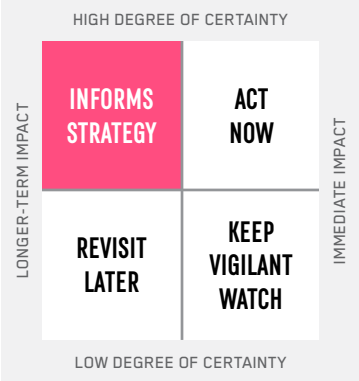
Watchlist

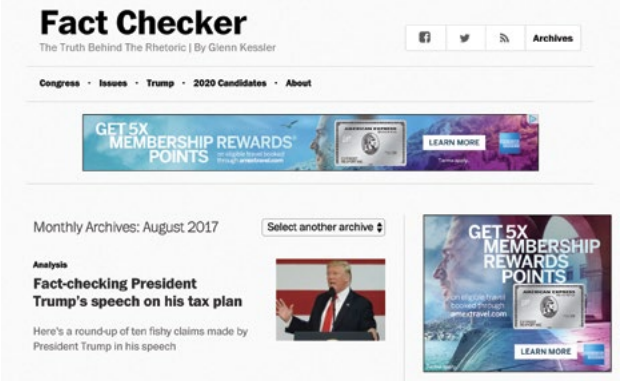
Nielsen; Chartbeat; YouTube; Google; Instagram; Snap; Facebook; Twitter; news organizations everywhere.

FOURTH YEAR ON THE LIST

Real-Time Fact Checking

123





The Washington Post has been experimenting with faster fact-checking.

Key Insight

Buoyed by charges of "fake news," real-time fact-checking–powered by both people and algorithm–will be a priority for journalists in 2018.

Examples

Digital tools have made it easy to report on a live event and publish in real time, but adding context–such as whether or not a source's statement is factually accurate–usually happens after. In 2011, MIT student **Dan Schultz** launched **Truth Goggles**, which originally enabled users to fact-check stories on the Internet. Truth Teller was mechanized, transcribing videos using speech recognition, and it eventually pivoted into a broader annotation tool. In 2016, the presidential debates were fact checked by a number of groups, including **National Public Radio (NPR)**, the **Washington Post**, and even **Hillary Clinton's** own staff. The efforts were people-powered. In February 2017, Washington Post reporters fact checked President Trump's address to Congress with very little lag.

What's Next

Late in 2016, **Google** introduced a fact-check tag to its **Google News** service–readers can see fact checks next to trending stories. As we now see on a near-daily basis, inaccuracies and falsehoods quickly spread on social media masquerading as the truth. At least when it comes to citing numbers and data, artificial intelligence will soon allow news organizations to automate the fact checking process. In a few years, AI systems will enable more sophisticated fact checking: explaining whether information was taken out of context, or exaggerated, or downplayed.

News organizations have a tremendous opportunity to use AI along with social media data and their own article databases, to build tools for real-time fact checking, adding a critical editorial layer that's both good for the public interest and good for building brand reputation.

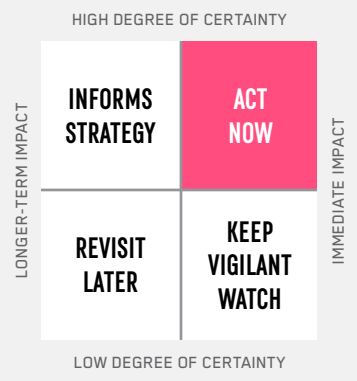
Watchlist

IBM Watson; Tencent; Baidu; Google; Amazon; Facebook; Twitter; news organizations everywhere.

THIRD YEAR ON THE LIST

Offline Is The New Online

124



New techniques allow consumers to access news content, even when they're not on a strong network.

Key Insight

As consumers shift to their mobile devices, developers are making sure their apps work offline.

Examples

In the U.S., consumers now spend an average of five hours a day on their mobile devices. As consumers move about our days–commuting, walking around the office, or enjoying a Little League game–they still find themselves offline. A number of news aggregators–including **Google**, **Smartnews** and **Apple**–want to capitalize on the time consumers devote to their screens, even when the WiFi signal is weak. The **Washington Post's** progressive web app cuts mobile page load times from 4 seconds to 80 milliseconds and allows consumers to read news stories without a data or WiFi connection.

What's Next

Until news consumers have ubiquitous access to cheap, fast data, offline reading will be a necessity. News organizations that include seamless, offline experiences will find sticker audiences.

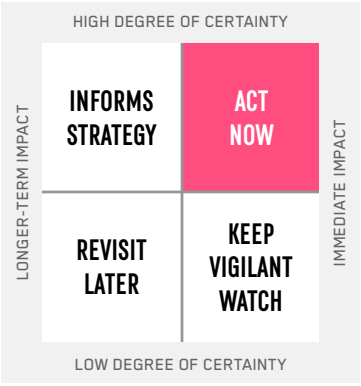
Watchlist

Tencent; Baidu; Google Play; Pocket; Amazon; news organizations everywhere.

SECOND YEAR ON THE LIST

Audio Search Engines

125



Audioburst uses artificial intelligence to index audio broadcasts and make them easier for consumers to find.

Key Insight

As news organizations venture into podcasts, new search tools allow the newsroom—as well as news consumers—to find exactly what information they're looking for within audio-only content.

Examples

While developers have learned how to quickly index and display web content, digital audio has always remained an unsolved challenge. Now, rather than searching for a topic and getting a bunch of hyperlinks to click through and listen to, consumers will instead receive a series of buttons that play the exact snippet of audio that's related to their search. Better than buttons, consumers can also speak their searches to a voice assistant and immediately get to the podcast they were trying to remember, to replay a news report they'd heard in the car, or to get a series of clips related to a subject they're interested in.

Startup **Audioburst** uses artificial intelligence to index audio broadcasts and make them easier for consumers to find. Rather than searching for keywords, Audioburst uses natural language processing to automatically discover the meaning conveyed and to surface the right content. For example, if a consumer wants an update on how close the **U.S.** is to a conflict with **North Korea**, she can ask a voice-activated app (**Amazon's Alexa, Google Home**), which will sift through audio information and deliver a set of clips.

What's Next

With so much funding and development into voice interfaces, audio search will quickly become one of the most important tech trends in the years to come.

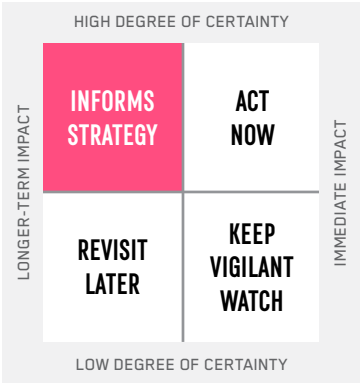
Watchlist

Audioburst; Amazon; Google; Apple; Advanced Media; Viacom.

SECOND YEAR ON THE LIST

Synthetic Data Sets

126



Synthetic data sets could help programmers build software without raising privacy concerns.

Key Insight

In the wake of privacy scandals, researchers are starting to experiment with synthetic data sets to perform meaningful analyses. This would increase the value of datasets that everyone uses–such as the Census–while protecting their confidentiality.

Examples

Researchers from the Data to AI Lab at the **MIT Laboratory for Information and Decision Systems** are developing a machine learning system to automatically create synthetic data, which could then be used to develop and test data science algorithms and models. They propose a **Synthetic Data Vault**, which would be able to learn and develop multivariate models for any number of purposes. In their testing, the synthetic data gave the same results as real data–without compromising privacy. Synthetic data sets hold promise for lots of applications and organizations, ranging from retail to healthcare to the federal government.

Policymakers, in particular, are interested in getting better data to make our future autonomous transportation systems reliable and safe. At the moment, companies like **Uber**, **Lyft**, **Apple**, **Google** and **Waze** hold an enormous amount of real-world data–handing it over to the government would violate the public trust. Instead, trip data could be converted into synthetic data, modeled using trips that people take.

A number of agencies collect detailed information for the purpose of generating statistical models. For example, the **U.S. Census Bureau** gathers a wealth of information, such as age, gender and income. It also collects similar data on businesses, including annual payroll and employment. While this information is vitally important to researchers, allowing everyone access to it presents a privacy challenge. For example, programmers need data sets to create and test new algorithms. But the numbers matter–so creating a statistically identical set of 1000 people without divulging their exact details has been a difficult task. During the past few years, a number of new approaches have been tried, including the experimental **Synthetic Longitudinal Business Database (SynLBD)** from the Census Bureau.

What's Next

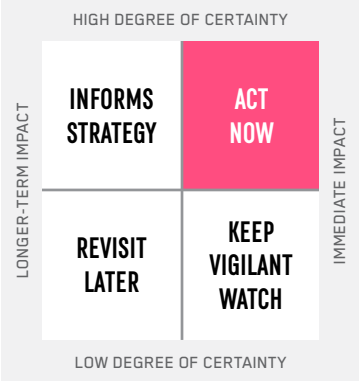
While some researchers argue that synthetic datasets aren't useful beyond testing algorithms and computer models, we think that increased privacy concerns will lead to the creation and use of more sets like the SynLBD. The **Data Observation Network for Earth (DataONE)** is working on datasets that can be shared by researchers all over the world. One future challenge: synthetic data still needs to be verified.

Watchlist

DataONE; National Association of City Transportation Officials (NACTO); World Resources Institute; U.S. Census; University of California-Davis; Purdue University; OECD's International Transport Forum; Duke University; SharedStreets; University of New Mexico; U.S. Geological Survey; ESA Data Registry; Knowledge Network for Biocomplexity; SANParks Data Repository; U.S. National Science Foundation; Uber; Lyft; Alphabet; Apple; Waymo; Didi Chuxing; Ofo; Mobike.

EIGHTH YEAR ON THE LIST

VIDEO



127-129

Key Insight

U.S. and U.K. adults now spend close to an hour a day watching online video, and increasingly we're using our mobile phones to access that content. But not all adults prefer video. A **Pew Research Center** survey found that more Americans prefer to watch their news (46%) than to read it (35%) or listen to it (17%). Meanwhile, the 18-34-year-old American millennial spends three hours a day watching TV programming, which is more time than they spend on YouTube, Netflix, Hulu, Twitch, Facebook and Instagram combined.

127

Connected TVs

TVs that connect to the internet certainly aren't new. What's changed is penetration in average households and the availability of streaming apps that bypass the standard list of cable and public broadcasting channels, such as **Amazon Prime Video**, **Roku**, **Hulu**, **YouTube**, **Showtime Anytime**, **iPlayer** (UK-only), **All 4** (UK only), **Playstation Now**, **HBO Now**, **Direct Now**, **iTunes**, and of course, **Netflix**.

Impact on news media orgs and publishers

Streaming services will erode local broadcast news markets. These services will also disrupt longer-form television news broadcasts. But they do open the door for video adaptations of books, both fiction and nonfiction.

128

Decentralizing The Web

The web is growing decentralized. There are a number of new approaches to publishing and receiving content that bypasses the usual centers of gravity–the blockchain, WebRTC, and private networks.

WebRTC is the real-time communications technology supported by Alphabet, Mozilla and Opera, and it powers **Google Hangouts**. WebRTC can be used to connect your smartphone to the articles you're reading on your desktop or tablet, displaying different components depending on what offers the best user experience. If a video won't display well on your current device, you could be offered a different version automatically. Because WebRTC works from the browser, it's also part of one of the other trends we're continuing to watch: connected machines.

Impact on media orgs and publishers

For news organizations, this means that rather than bridging computers to networks, which must route and relay information along various channels, WebRTC and similar peer-to-peer technologies could help computers talk to each other without obstruction. This may seem like a subtle change in Internet architecture, but consider the implications: you would no longer need a third-party operator, like **Skype**, to video conference with a friend–or to broadcast live news to consumers. Videos would load and play faster and would have no need to buffer.

129

Streaming Social Video

Facebook, **Snapchat**, **Instagram** and **Twitter** all offer live streaming video services–to anyone, for free. This means that for the first time in history, no technical knowledge or specialty equipment is required to broadcast the news. As a result, we are seeing a number of newsworthy events now appearing, completely unfiltered, across social media channels: funerals, arrests, political rallies, conference speeches, encounters with public officials.

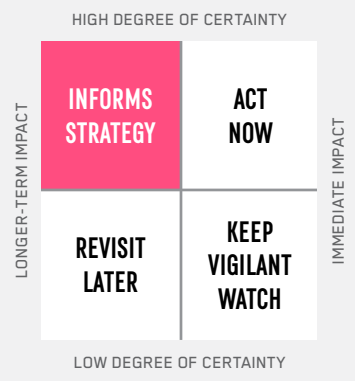
Impact on media orgs and publishers

Streaming social video is a good way for publishers to extend their traditional platforms from books and ebooks to reach a broader audience. While everyone can stream–and news organizations now have access to that content–we must ask whether everything *should* be broadcast. News organizations need a framework to determine whether rebroadcasting a murder, suicide or violent act streamed via social video is in the public interest.

SECOND YEAR ON THE LIST

New Video and Audio Story Formats

130



Hardcore Henry is a science fiction movie experienced through the main character's point of view.

Key Insight

With voice interfaces coming online, and new technologies such as augmented reality and virtual reality moving from the fringe to the mainstream, standard storytelling formats no longer apply. News organizations will start to develop new storytelling formats.

Examples

Storytellers have started producing stories built specifically for immersive environments. In 2016, **Lionsgate** and **SilVR Thread** produced a short action movie featuring a high-speed police chase—which viewers experienced virtually through the central character, played by Emma Roberts. Hardcore Henry, science fiction movie about a telekinetic warlord who plans to bioengineer soldiers, was shot entirely in the first person point-of-view and was intended to be viewed in VR.

What's Next

As consumers become more familiar with mixed reality interfaces and devices, the old storytelling formats won't necessarily translate. Audio stories intended for radio won't necessarily translate to aggregrated clips played on digital assistants, such as **Amazon's Echo** or **Google Home**. News organizations should begin experimenting now with POV storytelling templates and story formats specifically developed for emerging technologies.

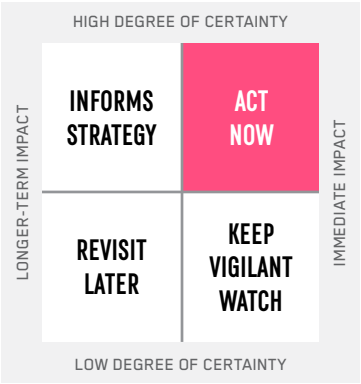
Watchlist

Magic Leap; Amazon; Alphabet; Facebook; Nvidia; Sony; NextVR; Curio.io; Oculus; IrisVR; Imax; Microsoft; Samsung; Qualcomm; Intel; LG; Huawei; Zeiss; Xiaomi; HTC; Lenovo; HP; YouTube; Jaunt; Pie; Wevr; Cluster; ZeroLight; Hyve.

THIRD YEAR ON THE LIST

Media Consolidation

131



News and media organizations are consolidating in the U.S., due in part to regulatory changes.

Key Insight

We are starting to see a handover of sorts: the shrinking of traditional media companies just as newer media organizations are consolidated under single owners. In the U.S., FCC Chairman Ajit Pai has made it easier for companies to consolidate.

Examples

In the past two years, **Sinclair**, one of **America's** largest local television station owners, agreed to purchase **Tribune Media** for $3.9 billion plus debt, while **AT&T** agreed to buy **Time Warner** at a staggering $85 billion. Chicago-based Tronc, which was spun off from **Tribune** in advance of the sale to Sinclair, acquired the **New York Daily News** for $1 (that's just one dollar)–along with the tabloid's pension liabilities and operational debts. It would be difficult to overstate just how much movement and consolidation is underway.

Efforts have been helped by the **Federal Communications Commission**, which under commissioner **Ajit Pai** has been in the process of changing key rules in favor of consolidation. The FCC reinstated what's called the "UHF discount" and has made it easier for broadcasters to consolidate ownership. It also passed a media ownership order that now allows newspaper-broadcast and radio-TV cross-ownership. It also removes a prohibition against two stations in a market being owned by one entity.

Univision won the bankruptcy auction for **Gawker Media Group** (and killed **Gawker.com** after the sale). **AT&T**, which owns **DirecTV**, considered bids for **Starz**, **Paramount Pictures**, and in the end, won **Time Warner**. **Re/code** became part of **Vox**, which became part of **NBC**, which a while back became part of **Comcast**. **Verizon** acquired **AOL**. The **Financial Times** was acquired by Nikkei (for a staggering $1.3 billion). The **New York Times** acquired **The Wirecutter**, **Complex** was acquired by **Hearst** and **Verizon** in a joint venture, while **Thrillist**, **NowThis** and **The Dodo** merged with **Seeker**, a division of **Discovery Communications**, and formed **Group Nine Media**. Tech startups **Newsy** and **Storyful** were both acquired by **E.W. Scripps** and **News Corp** respectively.

What's Next

The next 24 months will be about rapid product creation and monetization in a rush for investment and exits–driven by the FCC's loosening restrictions and a Department of Justice antitrust lawsuit blocking AT&T from buying Time Warner. By the year 2021, it's possible that **AT&T**, **Verizon**, **Comcast**, **Charter** and **Amazon** will have replaced **CBS**, **Viacom**, the **New York Times**, **Hearst** and **Conde Nast** as the biggest news and entertainment media brands in the U.S.

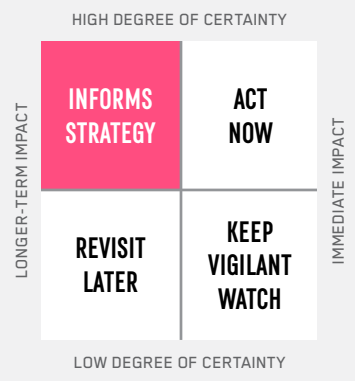
Watchlist

The FCC; Comcast NBC Universal; Amazon; Axel Springer; Viacom; Baidu; Bertelsmann; Time Warner; News Corp; Discovery; Disney; SoftBank Capital; AT&T; Vox; Vice; Netflix; Hearst Ventures; Facebook; Twitter; Alphabet; Yomiuri Shimbun Holdings; Tronc; Sinclair Broadcast Group; CBS Television; Nextar Broadcasting Group; Raycom Media; E.W. Scripps; Univision; Cox Media Group; Meredith Corp; Hubert Burda Media; Asahi Shimbun Company; Microsoft; Grupo Globo; News Corp; Univision; news organizations everywhere.

FIRST YEAR ON THE LIST

Tweaks To Social Network Algorithms

132



Facebook announced in January 2018 that it would change some of its policies to help root out fake news and misleading content.

Key Insight

In the wake of 2017's #FakeNews fiasco, social networks including Facebook and Twitter have promised to tweak their algorithms to curb the spread of bot-generated content. Throughout 2018, we expect to see various changes–not all successful.

Examples

In late 2017 and early 2018, Facebook was testing different versions of its News Feed around the world. News Feed includes content pulled from verified, professional news websites. The company said that it's hoping to have "meaningful interactions" on its website–and as as a result will be demoting content from publishers and brands.

What's Next

The challenge is that algorithm changes tend to happen in real-time, with live audiences. Not all scenarios have been mapped and tested. This became apparent when a fake story about a Muslim man, warning others about a planned terrorist attack in Slovakia, went viral. Local police issued a statement correcting the story, but since it came from the official police station's account, tweaks to the News Feed algorithm prevented Facebook users from seeing it. As social media companies experiment with better ways to curb the spread of fake and misleading information, we are to see glitches and potentially even more fake news stories being spread in 2018.

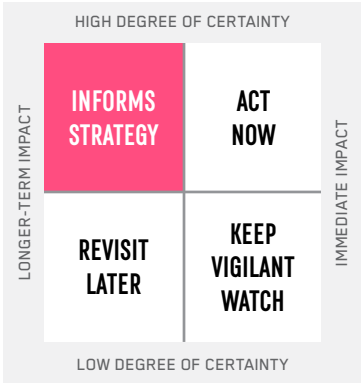
Watchlist

Facebook; Instagram; Twitter; Snap; digital advertisers; digital marketers.

THIRD YEAR ON THE LIST

The First Amendment in a Digital Age

133



Legal scholars don't all agree on how to protect free speech in a digital age.

Key Insight

It may seem odd to include the **Bill of Rights**, which were ratified 225 years ago, in an emerging tech trends report. But recent discoveries in how our technology renders speech will result in First Amendment challenges in the years to come.

Examples

In the aftermath of violent, racist demonstrations at a "Unite the Right" rally in **Charlottsville**, **GoDaddy** and **Google** dropped services to neo-Nazi websites. Earlier, in March 2016, **Microsoft's Tay.ai** bot went on an anti-Semitic, homophobic, racist rampage. The bot was decommissioned within 24 hours, but screenshots of its automatically-generated tweets are all over the internet. It proved to be a temporary headache for **Microsoft**, but the legal questions continue to perplex **Twitter**, **Facebook**, **Snap**, **Instagram**, **YouTube** and **Twitch**. How does the free speech apply to bots? Who's libel? The bot? The bot's well-meaning developer? The brand? The First Amendment clearly applies to the government suppression of speech—but does it relate at all to speech distributed by ISPs and search engines?

What's Next

The problem isn't just limited to the U.S. In 2015, a bot programmed by Amsterdam-based **Jeffrey van der Groot** autonomously wrote and tweeted a death threat, which resulted in Dutch police having to figure out whether or not a criminal charge was even possible. As of January 2018, there were more than a dozen active lawsuits challenging hate speech distributed via digital media. We anticipate legal challenges worldwide in the next several years.

Watchlist

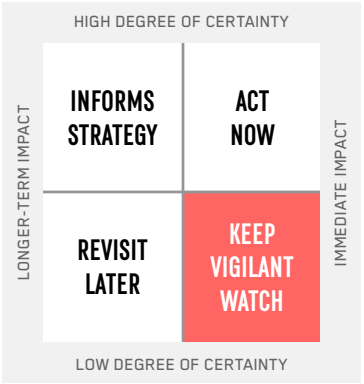
European Union; Federal Communications Commission; Google; Facebook; Microsoft; Apple; Amazon; Snap; Instagram; YouTube; Twitch; broadcasters; newspapers; radio stations; digital media organizations; Jack Balkin, Knight Professor of Constitutional Law and the First Amendment at Yale Law School; Margot Kaminski, Assistant Professor, Moritz College of Law, The Ohio State University.

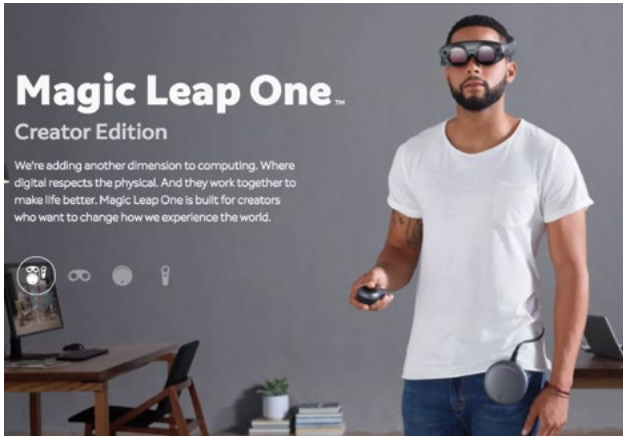
ENTERTAINMENT MEDIA

FIFTH YEAR ON THE LIST

MIXED REALITY

134-137





Magic Leap, which continues to raise investment funding, launched its SDK and developers platform.

Key Insight

Mixed Reality (MR) combines the physical and digital realms and encompasses a number of technologies: **augmented reality** (AR), **virtual reality** (VR), **360-degree video** and **holograms**.

What You Need To Know About MR

AR, VR, 360-degree video and holograms aren't new. But in the year ahead, we'll see more devices being made available to consumers at affordable prices–and we'll see a number of new content providers building out stories and experiences for each platform. This is a prioritized summary, based on our research and analysis, of how news organizations should invest their time and money.

134

Holograms

In the summer of 2017, researchers at the **University of Rochester** unveiled the Illumyn 3-D Display, a system that uses laser projection to generate 3D images in midair–sort of. They're contained in air that's enclosed within a glass sphere field with a metallic vapor. **RED**, the professional camera maker, built a holographic phone called the **Hydrogen** that generates holograms. **Microsoft's** long-awaited and much-hyped Hololens headset and SDK became available for developers in 2017.

Bottom Line

Hologram technology is still in development and too early for most organizations.

135

Virtual Reality

Virtual Reality (VR) is a computer simulated environment. As a tethered experience, VR is experienced wearing a pair of goggles, and it can stimulate sensations of being physically present in the scenes a user is viewing. VR can be experienced untethered as well, by slipping a mobile phone into a special mask. In 2017, a number of headsets went on sale from **Google**, **Microsoft**, **HTC**, **Oculus** and **Sony**. Because the environment is still very new, with relatively few content offerings, the relative value of VR HMDs (aside from Google's **Daydream View**) isn't yet attractive for average consumers.

Bottom Line

The VR marketplace become mature, but it's still early for widespread adoption. VR presents greater opportunities for entertainment, movies, shows and gaming.

136

360-degree Video

360-degree video is created with a special camera system capable of recording 360 degrees of a scene simultaneously. Once the video is rendered, viewers can use a mouse, their fingers, or gesture to watch the video from any perspective or angle. **YouTube**, **Facebook** and **Vimeo** offer 360-degree videos, and we expect more platforms to offer it in the year ahead.

Bottom Line

Because 360-degree videos don't require separate hardware for viewing, it offers a cost-effective alternative to VR that has greater market potential in the immediate term.

137

Augmented Reality

Augmented Reality (AR) doesn't simulate an entirely new environment, but rather overlays information right onto your field of vision. But you need a lens and screen of some kind, whether that's a mobile phone or a pair of glasses. In 2017, every major tech company, from **Alphabet** to **Facebook** to **Snap**, made big announcements about investing heavily in the future of AI.

Meantime, **Magic Leap**, which continues to raise investment funding, launched its SDK and developers platform–and it will be using a new kind of lightfield chip. Magic Leap projects light directly into the user's eye, which makes it seem as though digital objects exist in the real world.

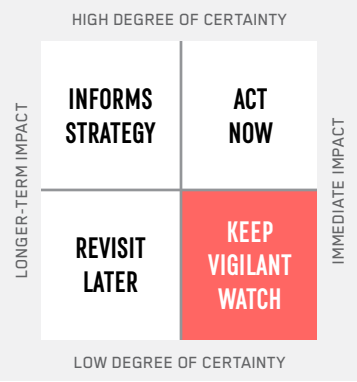
Bottom Line

AR offers the greatest market potential for organizations in the near-future.

FIRST YEAR ON THE LIST

Mixed Reality Arcades

138



Mixed Reality arcades are bringing games to everyone using new business models and cutting-edge equipment.

Key Insight

There are a host of fun, interactive mixed reality games on the market–but not everyone can afford the computer and gaming equipment necessary to play. As a result, a new kind of arcade for the next-generation of gamer is coming to a venue near you.

Examples

In the 1980s, video game arcades became popular–at first with geeky kids and then the mainstream masses, as Pac Man, Galaga and Space Invaders consoles popped up all around the world. They took off because kids and adults alike both loved playing them–and because early at-home consoles and computers were still too costly for the average person. We're in a similar transition in 2018, as VR games move from the fringe to the mainstream. Mixed Reality gaming parks are opening up everywhere, giving everyone the ability to strap in to a host of games–but this time around, they don't take quarters. Startup **Virtual World Arcade** offers a membership packages for unlimited VR time. In Tokyo, **VR Park** offers more than basic games–players can opt-in to swinging harnesses, flying platforms and platforms that simulate bungee jumping, flying and yes, even falling off skyscrapers.

What's Next

Mixed Reality arcades are proving to be a big business. We expect that as the MR market matures, we'll see additional arcades opening up everywhere. One distinction that might keep MR arcades from going the way of Pac Man–all the haptic interfaces. As games become more immersive, players will need to update more than their headsets and consoles. At some point, it might be easier and more cost effective to buy a membership rather than a new flight suit every few months.

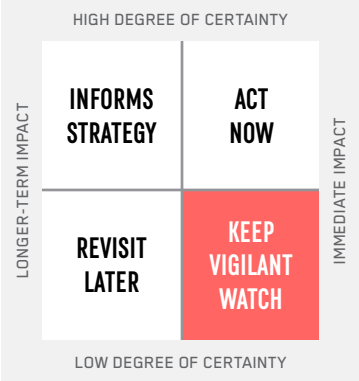
Watchlist

Intel; Grand View Research; HTC; Samsung; Viveland; Oculus; Facebook; Alphabet; VRNISH; Inception VR.

FIRST YEAR ON THE LIST

MMOMRGs

139



Second Life players built an MMO inside of it called Remnants of Earth.

Key Insight

MMORPGs–massively multiplayer online role-playing games–have been a staple of the online gaming community for years. A huge number of players interact with each other in a virtual environment. ***World of Warcraft*** and ***Final Fantasy*** are incredibly popular MMORPG's. ***Second Life*** was a virtual world–and in 2015, players even built an MMO inside of it called ***Remnants of Earth***. What's coming next are MMORPGs that are built using mixed reality.

Examples

Creating a virtual world is difficult enough. Making that world immersive, so that you can enter it using VR or AR, and still interact with other avatars under a wide variety of circumstances, is incredibly complicated. Another hallmark of MMORPGs is that they take a really long time to play. It's hard to imagine wiring in to a gaming system and physically moving your body around for hours at a time, swinging virtual swords at goblins or running to catch up with friends.

What's Next

Sony's CSL has built a mixed reality headset, allowing collaborative play between players who can see each others' views. **Orbus VR** is an early attempt at a new kind of game allowing players to move around their rooms, go on quests with friends and chat with others. It's likely that a new breed of MMORPGs–a sort of hybrid ***Second Life*** and ***EVE Online***–could be lurking just around the corner. This could also set the stage for future MMORPGs that offer more than quests and dragons–specialized worlds could be built for online dating, training and even diplomacy.

Watchlist

Ubisoft; Sony CSL; Sony PlayStationOrbus VR; Oculus; HTC; Survios; Alphabet; Apple; The Void; Harmonix; Otherside Entertainment; ILMxLAB; VRX Networks; Steel Crate Games; Playful Corp; Microsoft; Magic Leap; CCP Games; Activision Blizzard Entertainment; Electronic Arts; Tencent.

Virtual Vocabulary:

A mini-glossary for the virtual reality terms you'll need to know in 2018

CINEMATIC VR
VR created with video and images from the real world. (The alternative is computer-generated graphics).

EYE TRACKING
A system that can read the position of the user's eyes while using VR. Eye tracking software allows a user to aim correctly with her head while in a simulation.

FIELD OF VIEW (FOV)
What a user can see in her visual field while in a simulation. The viewing angle for an average, healthy human eye is about 200 degrees, so a field of view close to or greater than that is optimal, because it creates a true sense of being within an environment.

HAPTICS
In addition to a VR headset, hand-held controllers are often used. Some are equipped with haptic feedback, which gives the user the sensation of touching something in the simulated environment or receiving touch-back reactions.

HEAD MOUNTED DISPLAY (HMD)
This is the headset you've seen people wearing. It typically includes a strap both around and over the head, which secures the screen to your face. Some HMDs include built-in headphones as well as sensors for head tracking.

HEAD TRACKING
Some HMDs are equipped with special sensors that track the exact movements of the user's head. The sensors then send feedback to the system, which moves the images and audio a user experiences in her field of vision in real-time.

IN-EAR MONITORS (IEM)
These are earbuds that work with head mounted displays that don't offer built-in headphones.

LATENCY
Sometimes, the system isn't capable of showing the images in exact synchronization with the user. When that happens, a user moves her head, but the images she's seeing lag behind a few fractions of a second. This lag is a reason why some people experience "simulation sickness."

Virtual Vocabulary:

A mini-glossary for the virtual reality terms you'll need to know in 2018

PRESENCE
When a user feels as though she's fully immersed within a simulation, like she's actually there, she's achieved "presence."

REFRESH RATE
How quickly the images are updated. Higher refresh rates cut down on latency and provide a more realistic simulation. Ideal refresh rates are above 60 frames per second.

ROOM SCALE
This is the tethered version of VR that offers users the capability of walking around a room and interacting with virtual items, as they walk around in the physical world. So if you take a step in the real world, you're also taking a step in the virtual simulation. For this to work, rooms need to be mapped in advance.

SOCIAL VR
When two or more people are wired in to a VR simulation and able to share the experience by observing each other, interacting or participating in joint activities.

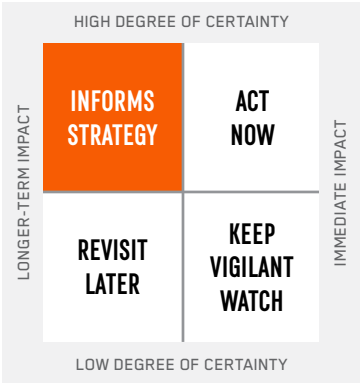
STITCHING
The process of combining video from different cameras into one, spherical video suitable for VR. This typically requires a tremendous amount of editing to fill in gaps, reorient scenes and seamlessly meld video streams so that the simulation looks authentic.

VR FACE
When a user has been in a simulation, a few things happen: the head mounted display tends to leave a temporary imprint on the skin, not unlike a pair of swimming goggles. Users also tend to relax into a slack-jawed look, with their mouths slightly agape.

MARKETING AND ADVERTISING TECHNOLOGIES

SECOND YEAR ON THE LIST

VR For Marketing



VR is being used for both B-to-B and B-to-C marketing.

140

Key Insight

Emerging research suggests that virtual reality storytelling, when it's done well, rewires all of us–we are likely to develop new belief biases as a result.

Examples

For more than a decade, scientists have been studying "**virtual reality exposure therapy,**" which has been used extensively to treat veterans suffering from post-traumatic stress syndrome. Because VR is completely immersive, it can closely simulate nearly any scenario. Patients, guided by trained therapists, are embedded into VR stories that represent a trauma they've experienced. Over time, this therapy results in new neuropathways–beliefs, attitudes and reactions are changed, for better or for worse. This presents an interesting opportunity for marketers.

What's Next

VR is being used for both B-to-B and B-to-C marketing. **Key Technology**, which manufactures food processing systems, built a VR marketing experience to help vendors see its digital food sorting platform in action. **Lowes** stores offers virtual skills training in VR, guiding DIYers through home improvement projects. Both **BMW** and **Volvo** have created apps allowing would-be buyers to test drive one of their cars. But unlike the usual test drive with a nagging salesperson trying to convince you to buy the upgraded sport model package, you instead interact with the vehicle on gorgeous open roads, in the best possible weather, all by yourself. Spend enough time with the apps, and your belief bias will shove your logical mind into the back seat. You might start to think that inside one of those cars, every day is a traffic free holiday where you have the driving skills of **Formula One** superstar **Lewis Hamilton**. This, of course, highlights an impending ethical challenge.

VR headset sales jumped 75% year over year in 2017, and we anticipate more growth in the coming year. In 2018 brands will have a unique opportunity to tap directly into our minds, persuading us through immersive storytelling.

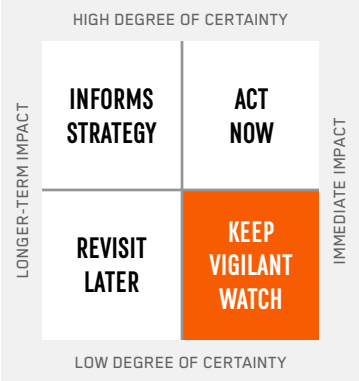
Watchlist

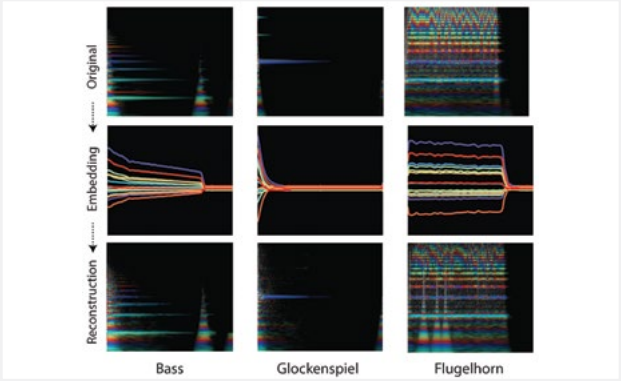
HQSoftware; Deep VR; 360 Profilms; Light Sail VR; Perception Squared; TaKanto VR; Circos VR; Helios Interactive; Rewind; Reverge VR; BBH; Goodby Silverstein & Partners; VirtualSKY; Leo Burnett; BBDO; Facebook; Droga5; Ogilvy & Mather; Razorfish; Weiden+Kennedy; GSD&M; VML; Critical Mass; Three One Zero; Valve; Wevr; Alphabet; Innerspace VR; StartVR; Epic Games; Survios.

FIRST YEAR ON THE LIST

AI In the Creative Process

141





NSynth is an AI-powered music composition tool from Google Brain.

Key Insight

Can AI learn to be creative? In the past few years, we've already seen examples of AI systems creating something from scratch—music, dress designs, bicycles, and more.

Examples

Last year, researchers from **Rutgers University**, **College of Charleston**, and **Facebook's AI Research Lab** created an AI system whose purpose was to make art. The result was so convincing that human art critics couldn't distinguish between the AI-generated works and those made by humans. That research builds on an earlier study (from Rutgers and Facebook's AI Lab) that trained an algorithm to identify a work's artist, genre and style of art.

What's Next

"**Break Free**" is a single from the album **IAMAI**, which was written, produced and performed using artificial intelligence. **Sony's Flow Machine** worked along a human lyricist and together, they created a popular song. **YouTuber Taryn Southern** used the **Amper AI** system to create her latest songs. **Aiva AI** is a composer intended to help film directors, advertising agencies and game studios create original scores for their projects. **Magenta**, a project from **Google Brain**, is being used to create art and music—anyone can use its **NSynth** tool to generate new music. AI being used in creative fields has some worried, especially since some of the robo-created works seem to appeal to humans as much as flesh-and-blood artists. Creative uses for AI is an important step in advancing the entire body of work and research, as we transition from artificial narrow intelligence to artificial general intelligence.

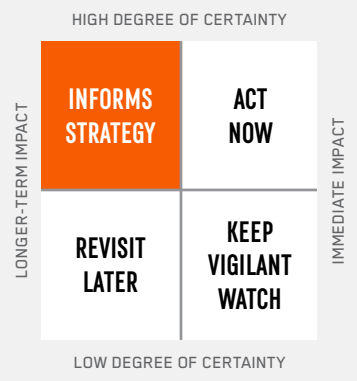
Watchlist

Alphabet; Rutgers University; Facebook; College of Charleston; Sony; IBM; Amazon; Baidu; Tencent; Alibaba.

SECOND YEAR ON THE LIST

FOBO

142



FOBO will appear in the WHO's upcoming 11th International Classification of Diseases.

Key Insight

If you're the kind of person who feels uneasy when your phone runs out of battery or when you can't get a decent WiFi signal, you're suffering from **FOBO**, or the "**fear of being offline**."

Examples

The **World Health Organization** now recognizes "gaming disorder" as a mental health condition, and it will appear in its upcoming **11th International Classification of Diseases**. While the WHO stopped short of classifying internet or digital addition in general, **Australia**, **China**, **Japan**, **India**, **Italy**, **Korea** and **Taiwan** all officially recognize "tech addiction" as a disorder. In 2013, Japan's Ministry of Education created "internet fasting camps" for young people who couldn't go offline. **China** operates 300 treatment centers, and there are 200 tech addiction centers in **South Korea**. Numerous professional psychological associations around the world, from the U.S. to Australia, are now encouraging their members to consider internet addiction as a behavioral compulsion worthy of treatment.

Emerging research shows that ubiquitous connectivity, our mobile devices, and social media have created new neural pathways causing us to feel varying levels of anxiety when we're prevented from taking a peek.

What's Next

Psychologists and mental health professionals warn that our FOBO and susceptibility to digital distraction isn't going away anytime soon. This is good news for anyone in marketing–we are a captive audience, growing weaker by the day. But consumers should think about how our current addiction will affect our ability to unplug in the longer-term.

FOBO could have implications for business. Some investors and activists are now likening our devices to Big Tobacco court cases, calling on tech giants like **Apple**, **Google** and **Facebook** to publicly admit that they've gotten us all hooked. **The California State Teachers' Retirement System**, which controls about $2 billion of Apple shares, are calling on Apple to study the long-term consequences of using **iPhones**, and they're asking for new tools to help parents limit phone use.

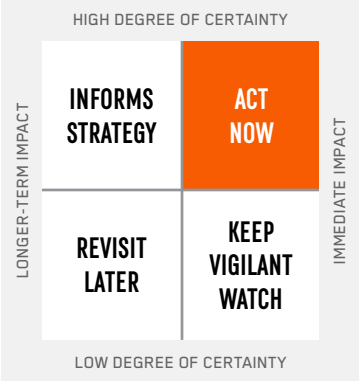
Watchlist

World Health Organization; Center for Internet and Technology Addiction; University of Connecticut School of Medicine; CalSTRS; tech companies everywhere.

SECOND YEAR ON THE LIST

Retail APIs

143



The Curbside ARRIVE API helps retailers predict when customers will arrive to pick up their products.

Key Insight

Retailers are making their data available to developers in the form of APIs in order to provide consumers and partners a host of new services.

Examples

Application programming interfaces, or APIs, are tools for building software applications. Retailers are using APIs to help customers and partners discover them more easily online, learn about products and services and to interact with the customer even when she's not shopping. In October 2016, **Mastercard** debuted a developer platform with 25 APIs to make it easier for startups and developers to integrate its payment services. Through its API program, **Walgreens** works with more than 275 partners. Home furnishings retailer **Wayfair** offers an API so that developers can build a 3D library—the goal is to help the company's expansion into virtual and augmented realty.

What's Next

Retailers need to expand their reach beyond brick and mortar stores, and also beyond the traditional e-commerce site. The **Curbside ARRIVE API** helps retailers predict when customers will arrive to pick up their products. APIs could give retailers a reason to keep their brick and mortar stores open—as more shopping shifts to online, APIs could be used as a clever way to keep consumers engaged in the physical world—using their digital devices.

Watchlist

MuleSoft; CVS; Walgreens; Mastercard; Wayfair; Zendesk; Walmart; Hershey's; Amazon; Lowes; Home Depot.

SECOND YEAR ON THE LIST

Digital Associates

144

Alibaba is already testing smart kiosks and smart digital assistants in China.

Key Insight

Like Digital Assistants, but with specific objectives. Digital Associates—found in augmented reality mirrors, roaming robots, and smart kiosks—will give consumers a reason to shop in the real world during 2018.

Examples

New smart mirrors are helping shoppers in the fitting room—suggesting which colors match a pair of pants, how to accessorize outfits and even showing alternate colors and patterns of an item being tried on. **Nordstrom**, **Top Shop** and **Nieman Marcus** have piloted the technology so far. Meanwhile in Japan, **SoftBank's Pepper** robot has been taking orders at **Pizza Hut**. In **China**, consumers interact with smart kiosks to order and pay—without having to pull out or swipe a credit card.

What's Next

Don't expect these digital assistants to completely supplant the human salesforce in 2018—at least not entirely. Any digital tool that makes the in-person shopping experience easier and more enjoyable for consumers is likely to court investment, not to mention brand loyalists.

Watchlist

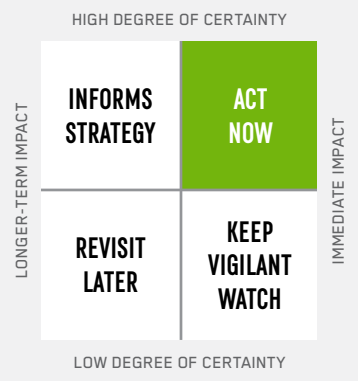
Alibaba; Tencent; MasterCard; SoftBank; IBM; Lowes; Keonn; Oak Labs; eBay Enterprise; MemoryMirror.

ENERGY

FOURTH YEAR ON THE LIST

Green Tech

145



New green tech initiatives are launching worldwide.

Key Insight

Electric vehicles, solar panels, wind turbines—even with a White House that repeatedly demonstrates its hostility to green technologies, 2018 will bring momentum to clean power.

Examples

In 2017, **President Donald Trump** pulled **America** out of the **Paris Climate Agreement**, saying that the U.S. would instead rely on coal and oil. The statement earned him support from his base (not to mention widespread ridicule from others). Regardless, the rest of the world has decided to move in a different direction. **China** is installing a record number of solar projects and wind turbines, to deal with crippling smog. The Chinese government is investing $560 billion over the next two years to make green tech more accessible not only within China, but for its export partners around the world. The U.S. is banning fossil-fuel cars by 2040; in **France**, the ban takes effect in 2030. Across **Europe**, the **Ionity** network will bring 400 charging stations online by 2020—in the U.S., we can expect to see 20,000 by that time. **Elon Musk** is partnering with a number of companies to build attractive solar panels that look more like slate shingles than the reflective rectangles we've seen to date—he, and others, are also developing new methods to create and store energy using battery systems.

What's Next

Extreme weather events and ongoing climate change have a lot of very smart people seriously worried. **The International Energy Agency** says that renewable energy will make up about 40% of the global power grid by 2040. We should see faster growth in green tech over the next five years than we have seen to date.

Even **Saudi Arabia** is working on a detailed, long-term plan to help diversify its economy and move away from oil. To do this, **Crown Prince Mohammed bin Salman** has bold visions for the future of his kingdom: allowing women to drive and to work in private employment, selling shares of **Aramco** (the Saudi state-run oil monopoly), and a "utility scale" solar project.

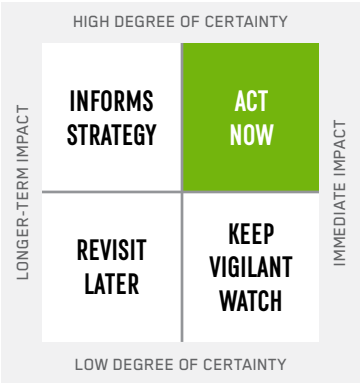
Watchlist

Canadian Solar Inc; First Solar Inc; Atlantica Yield PLC; Vestas Wind Systems; Xinjiang Goldwind Science and Technology; GCL-Poly Energy Holding Ltd; Pacific Ethanol; Renewable Energy Group; Toyota; CropEnergies AG; GCL-Poly Energy Holdings; Schneider Electric; Johnson Controls; ABB Ltd; Motech; Tesla; SolarCity; Panasonic; Vestas; Bombardier Phillips; Emerson Electric; Dong Energy; Xinjiang Goldwind Science; Frist Wind Solar; Samsung; Saudi Arabia Government; SoftBank; Apple; Amazon; Global Pvq SE; Hanergy Thin Film Power Group Ltd; Inox Wind; Hiangsu Akcome Science & Technology Co.

FIRST YEAR ON THE LIST

Charging Stations

146



Tesla plans to launch thousands of new charging stations around the U.S. in the next few years.

Key Insight

In the coming year, we'll see an unprecedented number of new charging stations for electric vehicles. It will be the beginning of an uncomfortable disruption for all those in the gasoline supply chain and retail business.

Examples

The E.U. is banning fossil-fuel cars by 2040; in France, the ban takes affect in 2030. **General Motors** is launching 20 new EV models by 2023, while **BMW**, **Nissan**, **Jaguar**, **Porsche**, **Audi**, **Volkswagen**, **Volvo** and **Tesla** will all have EVs out in 2018. As a result, we should see more charging stations throughout communities everywhere. Supercharging stations will help the EV market take off–there will be hundreds of new charging stations in Europe and upwards of 20,000 here in the U.S. by 2020–but it will start to have a chilling effect on independent and corporate gasoline station chains, as well as on the local communities that are supported by them.

What's Next

Everyone in the gasoline supply chain should get ready for disruption. Gas stations provide more than just fuel–they sell lottery tickets, cigarettes, maintenance items, chips, sodas, sweets and more. Once consumers no longer need to stop for gas, all of the adjacent industries will see an economic hit.

Now is the time for gas companies to envision their future business models.

Watchlist

Tesla; Ionity; Blink CarCharging; Envision Solar; AeroVironment; SemaConnect; ChargePoint; PlugShare; Saudi Aramco; Sinopec; China National Petroleum Corporation; Petro China; Royal Dutch Shell; Exxon Mobil; BP; Lukoil; Kuwait Petroleum Corporation; Chevron Corporation; Valero Energy; Conoco Phillips; Royal Farms; Wawa; Suncor Energy; vendors to gas stands; EV car manufacturers worldwide.

FIRST YEAR ON THE LIST

Ultra-High-Voltage Direct Current and Macro Grids

147

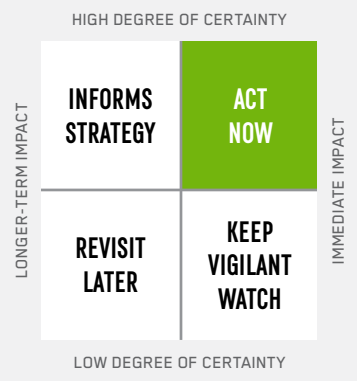


ABB has developed a new way to transmit power long distances.

Key Insight

In the near-future, we will transport clean energy from production sites to areas where power is needed, using a new kind of power grid.

Examples

In the **U.S.** and throughout **Europe**, electricity is generated at a power station and then transmitted using alternating current. But AC is inefficient over very long distances, and even smart grids haven't always been able to cope with climate change and our increasing consumer demands for heat and air conditioning. A new kind of transmission system–ultra-high-voltage direct current (UHVDCs)–is being tested in **China**, which has invested $88 billion to build the future of UHVDCs and macro grids.

What's Next

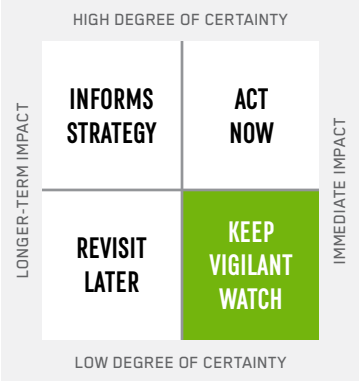
A national direct-current macro grid could drastically lower emissions in an affordable way, without compromising our access to electricity. Meanwhile, China has already moved ahead of the U.S. China is an enormous country, and it's heavily investing in green technologies. The first 800,000 volt line, from a dam in **Yunnan Province** to **Shanghai,** has already been completed. Next up, the Changji-Guquan system, which can carry half the entire power use of Spain spanning the east-west expanse of the country. China has made it known that it plans to transport clean energy all around the world. Fifty years from now, it's conceivable that we're all reliant on China–rather than **OPEC** countries (**Saudi Arabia**, **the UAE**, **Venezuel**a, **Iraq**, **Iran**, **Kuwait**, **Libya**, **Nigeria**, **Qatar**, **Algeria**, **Angola** and **Ecuador**) for our energy needs.

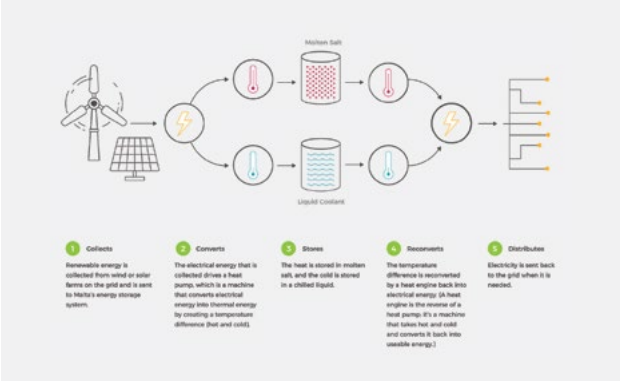
Watchlist

ABB; China; OPEC countries; TransWest Express Transmission Project; U.S. Department of Energy; the DOE's Grid Modernization Initiative.

FIRST YEAR ON THE LIST

Better Batteries





Alphabet's Project Malta aims to capture more clean energy when it's produced by using salt to store it on a large scale.

148

Key Insight

It's a common first-world problem: our devices never seem to have enough battery life, and just when we need power the most, we either forget our chargers or can't find a spot to plug in. Building a better battery has been an elusive challenge for decades–that might start to change in 2018.

Examples

In 2016, **South Australia** suffered a massive blackout, which **Prime Minister Malcolm Turnbull** blamed on renewable energy targets–the push towards renewables is what led to the problem, he argued. In response, **Elon Musk** offered to build a massive battery farm, capable of storing enough wind and solar energy to power all of South Australia when usage grew too high–and that he'd do it in 100 days, or the whole thing would be free. The local government accepted his offer, and Musk delivered on his promise, and the system has been up and running since November 2017.

Musk's battery is the size of an American football field–not exactly the right size for your mobile phone. But there are a number of researchers and startups hoping to bring new kinds of batteries, capable of storing renewable energy, to market soon.

What's Next

The problem with modern batteries isn't about making the power–it's how to store enough of it. Startup **Ossia Inc.** built a wireless charging system that can power AA batteries from 30 feet away. **Alphabet's Project Malta** aims to capture more clean energy when it's produced, by using salt to store it on a large scale. Luxury watchmaker **Ressence's** Type 2 e-Crown Concept smartwatch collects and stores energy created when you walk, as well as solar energy when you're outdoors. Cambridge, Massachusetts-based startup **Baseload Renewables** is working to market batteries that can store renewable energy in a battery. Lithium-ion batteries have limits, though, which is why researchers at the **University of California-Irvine** are experimenting with gold nanowires housed in a gel electrolyte, which can last significantly longer than today's batteries. Spanish startup **Graphenano** has built a battery out of graphene, while researchers at Toyota are looking at a solid state battery that uses sulfide superionic conductors. If you're someone constantly looking for a place to plug in, you won't need to worry for too much longer.

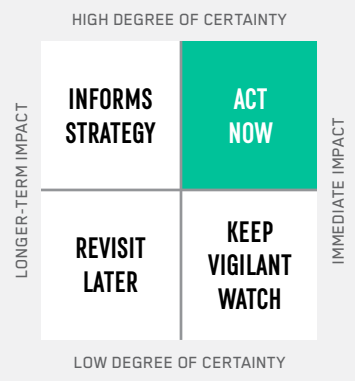
Watchlist

Tesla; Alphabet; Baseload Renewables; University of California-Irvine; Toyota; Nissan; Graphenano; General Motors; Huawei; Energous Corp; the Federal Communications Commission; Qualcomm; U.S. Department of Energy; MIT Department of Materials Science and Engineering; Ossia Inc; Khosla Ventures; Founders Fund.

CLIMATE AND GEOSCIENCE

FOURTH YEAR ON THE LIST

Anthropocene



Earth's new geological layers show that humans have left a permanent mark on the planet.

149

Key Insight

An international, independent team of scientists, called the **Anthropocene Working Group**, has now found enough evidence to support the official declaration of a new geological epoch. The group, comprised of scientists who were both in favor of and against declaring a new epoch, reached a consensus in early 2018.

Examples

Scientists within the AWG and outside have determined that humans have left a permanent mark on the planet. The new geological layers we are creating are riddled with chemicals and industrial waste, pavement, plastic, nuclear fallout, dams, everyday garbage, pesticide runoff and more. We've caused our sea levels to rise and our lakes and rivers to dry up, and extreme weather events are a normal part of daily living on Earth.

A new epoch is defined following a cataclysmic event–like the asteroid that collided with Earth and led to the end of the dinosaurs. It significantly and permanently alters the underlying sedimentary and rock layers beneath the surface of the planet, resulting in visible changes that can be seen and measured.

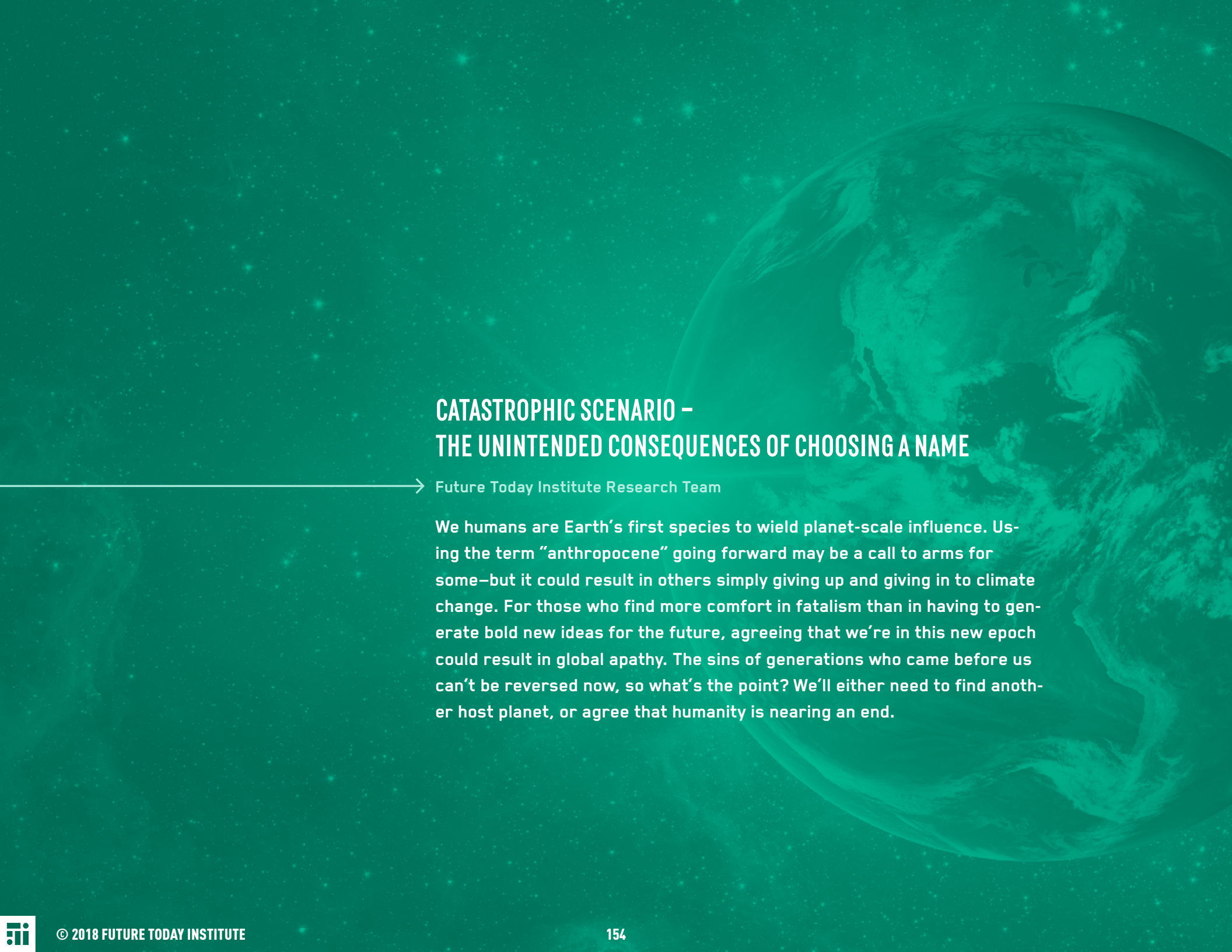
The "**Anthropocene**" (*anthro* for "man," and *cene* for "new") marks a new geographic epoch. (Our previous epoch was called the "Holocene," which began 11,700 years ago just after the last ice age).

What's Next

Recognizing that humans have made a permanent, visible mark on the planet is the first step in studying the future implications to our planet.

Watchlist

Anthropocene Working Group; the Union of Concerned Scientists; the International Union of Geological Sciences; the Nature Conservancy; U.S. Geological Survey.



CATASTROPHIC SCENARIO – THE UNINTENDED CONSEQUENCES OF CHOOSING A NAME

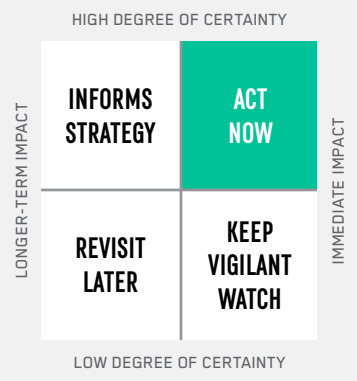
Future Today Institute Research Team

We humans are Earth's first species to wield planet-scale influence. Using the term "anthropocene" going forward may be a call to arms for some–but it could result in others simply giving up and giving in to climate change. For those who find more comfort in fatalism than in having to generate bold new ideas for the future, agreeing that we're in this new epoch could result in global apathy. The sins of generations who came before us can't be reversed now, so what's the point? We'll either need to find another host planet, or agree that humanity is nearing an end.

FIRST YEAR ON THE LIST

Extreme Weather Events

150



In 2017 and 2018, California residents battled extreme wildfires, brought on by severe drought.

Key Insight

An extreme weather event is one that falls outside the norms of typical weather patterns. They became a worldwide phenomena in 2017.

Examples

Bomb cyclones. Hurricanes off the coast of Ireland. Sudden wildfires that can't be contained, followed by mudslides that ravage entire communities without warning. In India and Pakistan, hundreds of people died when temperatures spiked. These were just a few of the extreme weather events we saw in 2017, and you can expect more of the same in the years to come.

Scientists at the **University of Arizona** and the **Swiss Federal Research Institute** have been studying climate change and discovered that the polar jet stream has been fluctuating more frequently since 1960. The dramatic fluctuations–further north and south–are connected to our warming oceans. Strong hurricanes, sudden freezes and droughts all plagued the U.S. in 2017, causing $306 billion in damage, making last year the costliest on record.

What's Next

As we're likely to see more extreme weather events in the years to come, now is the time for communities to prepare their citizens for weather-related emergencies. It's also time to talk about business and economic disruption. **The Trump Administration** continues to deny climate change and scrubs federal websites of facts and evidence-based reports, and it has withdrawn support for initiatives to combat extreme weather. As a result, American cities are threatening to sue some of the largest energy suppliers. **New York City** filed a lawsuit against **BP**, **Chevron**, **ConocoPhillips**, **ExxonMobil** and **Royal Dutch Shell** for damages caused by climate change, and in early 2018 the city council for **Los Angeles** debated whether they should do the same.

Meanwhile, air and road travel, as well as cruises, will see more weather-related delays, diversions and cancellations. Logistics and delivery companies will need to contend with delays and backups due to storms–this will mean unhappy customers as well as hardships for vendors and retailers alike.

Watchlist

National Oceanic and Atmospheric Administration (NOAA); NASA; Department of Energy; Department of Homeland Security; House Armed Services Subcommittee on Emerging Threats and Capabilities; Columbia University's Earth Institute; United Nations' Intergovernmental Panel on Climate Change; European Geosciences Union; University of North Carolina at Wilmington; Potsdam Institute for Climate Impact Research; National Center for Atmospheric Research.

PLAUSIBLE SCENARIOS FOR THE NEAR-FUTURE OF U.S. AGRICULTURE

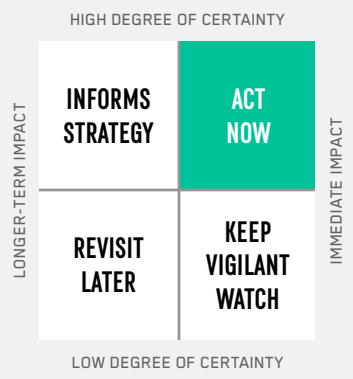
Amy Webb

In the future, extreme weather could shift the U.S.'s breadbasket states far north into Canada, and our citrus production from Florida and California to Tennessee, Kentucky and Ohio. Existing farming communities could be devastated within a generation. Another possibility: genomic editing makes it possible to produce more fruits, grains and vegetables, so our farms shrink in size and move underground and into buildings capable of withstanding big storms. Most of our agricultural sector is automated—collaborative robots and smart sensors plant, monitor, and harvest what we need. Our food is grown hyper-locally, year-round.

FIRST YEAR ON THE LIST

Human Migration Patterns Shift

151



We must prepare for a future wave of climate refugees.

Key Insight

Climate change is forcing people from their homes and communities. To date, we don't have an official designation for "climate change refugees," but that's likely to change in the near-future.

Examples

2017's **Hurricane Maria** triggered a mass exodus from **Puerto Rico**, causing one of the largest migration events in U.S. history. As of December, an estimated 215,000 Puerto Ricans fled the island for the U.S. mainland. Researchers from the **School of International and Public Affairs at Columbia University** looking at new flows of migrants worldwide, found that people who applied for asylum between 2000 and 2014 were increasingly on the move due to "weather shocks." A recent study by the **Environmental Justice Foundation (EJF)** says that tens of thousands of **Bangladeshi** families could soon face becoming climate refugees within their own countries. It's a problem that could soon get worse–a one-meter sea level rise could result in a 20% loss of Bangladesh's current landmass. And it's not just Bangladesh at risk.

A study by researchers at **Columbia University**, published in the journal ***Science***, showed the climate change could lead to 1 million climate refugees migrating into the **European Union** every year by 2100–creating breathtaking changes to our existing cities and infrastructure. Throughout the world, monsoons, droughts and scorching heat are driving millions of people away from their homes in search of more hospitable environments.

What's Next

The EJF worked with national security experts and retired military leaders to model scenarios for the future of climate change and human migration and concluded that the number of climate refugees could dwarf the number that has fled Syria in recent years. We could see a wave of migration from **Africa**, the **Indian Subcontinent** and from island nations into **Europe** and the **U.S.** It would be wise for intergovernmental organizations to begin talks about adopting official designation–as well as the corresponding protocols necessary–now, in preparation for near-future waves of climate refugees.

Watchlist

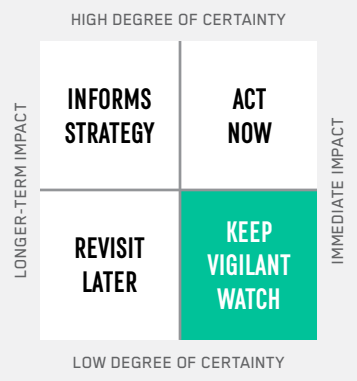
Environmental Justice Foundation; United Nations; UNHCR; Cornell University; European Union; Center For Migration Studies.

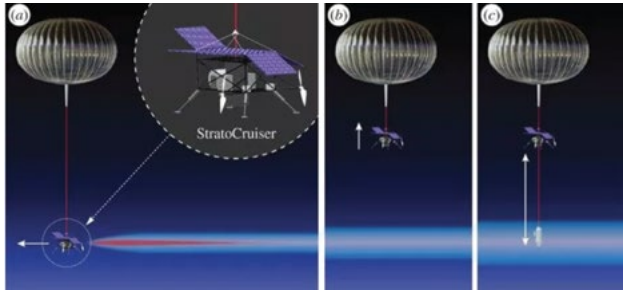
Climate change could lead to 1 million climate refugees migrating into the European Union every year by 2100–creating breathtaking changes to our existing cities and infrastructure.

FIRST YEAR ON THE LIST

Geoengineering

152





Harvard physicist David Keith and his team are planning an experiment this year that would spray a small amount of material (water, initially) into the stratosphere. Then it will fly through the spray with instruments to measure how those particles interact with the atmosphere, so scientists can start to understand whether geoengineering is even feasible.

Key Insight

To counteract extreme weather and climate change, researchers are looking to geoengineering–large-scale technological and scientific interventions to counteract the damage we've caused to the planet.

Examples

It probably sounds terrifying–or at the very least, like a plot from a big-budget sci-fi movie. Scientists are quietly researching massive geoengineering projects that could help stave off sea-level rise and curtail our planet's warming temperatures. One project from **Princeton University** scientist **Michael Wolovick** involves building massive piles of sand or other materials dumped to the sea floor, to **build walls around glaciers**–sort of like a scaffolding to prevent them from collapsing. Farther beneath the surface of the ocean is warmer sea water. As it moves closer to glaciers, it destabilizes the foundation, causing pieces to break off and melt into the ocean. Shoring up their foundation could keep glaciers submerged in the icy upper layers of water, and–theoretically–prevent them from melting. It's not a perfect method for all glaciers, but it can help slow some from melting. Another possibility is **oceanic iron fertilization**–dumping enormous amounts of iron sulfate into large swaths of the ocean. Theoretically, it would stimulate the growth of phytoplankton, the tiny sea life that absorb carbon dioxide, release oxygen and are gobbled up by other creatures. Some scientists have proposed launching **enormous, mirrored parasols** into the stratosphere, which would reflect sunlight back into space and (again theoretically) could cool the Earth's atmosphere over time. One of the most controversial ideas is to have a fleet of jets fly around the planet constantly and **inject sulfur dioxide gas overhead**, which could reflect the sunlight back.

What's Next

Scientists can run simulations using available data, but it's impossible to predict the second and third-order implications of geoengineering in advance. Even so, the fate of the whole planet is at stake. No one country can–or should–take the lead on geoengineering. **U.S. Secretary of State Rex Tillerson** said that climate change is "just an engineering problem".

Watchlist

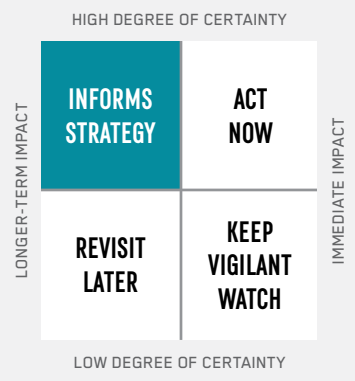
Princeton University; NASA; National Oceanic and Atmospheric Administration (NOAA); Department of Energy; Department of Homeland Security; Columbia University's Earth Institute; United Nations' Intergovernmental Panel on Climate Change; European Geosciences Union; Potsdam Institute for Climate Impact Research; National Center for Atmospheric Research.

AGRICULTURAL TECHNOLOGIES

FIRST YEAR ON THE LIST

Indoor and Outdoor Plant Factories and Microfarms

153



Microfarms will test autonomous growing techniques throughout 2018.

Key Insight

With extreme weather hampering traditional agriculture, new kinds of indoor and microfarms are endeavoring to see whether produce and grains can be grown in spite of climate change.

Examples

Japanese researchers in **Kameoka, Koto** are one of 200 plant factories–indoor microfarms–that can now grow enough hydroponic lettuce to feed local communities. The lettuce is grown without soil or sunlight and it takes only 40 days to mature before it's shipped to supermarkets around Japan. At the **Kansai Science City** microfarm location, much of the work is automated: raising seedlings, replanting, watering, adjusting the light and harvesting is all done using artificial intelligence and collaborative robots.

What's Next

According to the latest **U.N. estimates**, we're going to need to produce 70% more food by 2050 to meet global nutrition needs. Genomic editing techniques that are moving from the fringe to the mainstream, combined with AI and vertical staking techniques, could very well result in a future where we have microfarms housed underground, in our office buildings, and on neighborhood blocks. While it would disrupt our existing business models and the agricultural supply chain, it would mean better access to fresh, nutritious food in urban and rural communities alike.

Watchlist

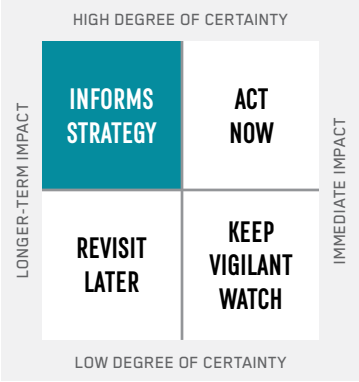
Japan Plant Factory Association; Japanese Ministry of Economy, Trade and Industry; Iwatani Agrigreen; National Federation of Agricultural Cooperative Association (Japan); Mistubishi; Chiba University; AeroFarms. Bright Farms; Detroit Dirt; Fujitsu; Grove Labs; Tomiyama Corporation; Monsanto; Sungenta; Bayer AG; DowDuPont; BASF; Del Monte; Komatsu; Claas; John Deere; AGCO.

We're going to need to produce 70% more food by 2050 to meet global nutrition needs.

SECOND YEAR ON THE LIST

Deep Learning For Farming and Food Recognition

154



Researchers are testing robotic harvesting systems that use image recognition.

Key Insight

Deep learning is being used to help identify food for a number of reasons: to help computers have more robust conversations with us about what we're eating, to calculate the number of calories in a dish, and to spot spoiled or tainted food.

Examples

Indian farmers can now snap and upload photos of their problem crops to **Plantix**, a cloud-based AI system that automatically recognizes the plant and likely disease, pest or nutritional deficiency. It's a game-changer for local farmers. California startup **Abundant Robotics** and Israeli-based **FFRRobotics** are both developing automated picking systems that scan and "read" produce to determine when it's ripe. **Blue River Technology**, recently purchased by **John Deere Labs**, is using deep learning to automatically detect and spray weeds.

On the consumer side, deep learning will soon be used to help us learn what's in the food we eat–and even where it came from. Computer models will be able to calculate the nutritional value of your meal before you take your first bite. Researchers at the **University of Massachusetts** are using deep learning for computer-assisted dietary assessments, while scientists at **Microsoft** have already incorporated their deep learning prototypes for recognizing popular Asian and Western foods into **Bing** local search engine. At the **MIT Media Lab**, students are working on an organic barcode that's invisible to us, but could be read by machines–it could be used to help consumers more easily trace produce as it moves around the world.

What's Next

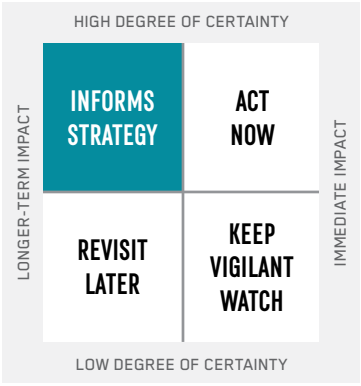
This technique can be used to find and sort bad products on food assembly lines, and it can help growers better identify crop disease. Deep learning for food recognition could soon mean a number of opportunities for agricultural companies, farmers, food manufacturers, restaurants and those watching their diets.

Watchlist

Abundant Rotobics; Plantix; FFRRobotics; Blue River Technology; John Deere Labs; Microsoft; Prospera; IBM; Alphabet (Google); University of Massachusetts; Apple; Carnegie Mellon; MIT Media Lab; University of Tokyo; Penn State University; University of Maryland; PlantVillage.

SECOND YEAR ON THE LIST

Smart Farms



New and emerging technologies will power farms.

155

Key Insight

In order for traditional agriculture to meet the global demand for food, researchers are trying to make farming look more like modern manufacturing.

Examples

The **UN's Food and Agriculture Organization** published an alarming report in 2009 stating that by the year 2050, global agricultural production must rise by 70% to meet projected demand. Current farms won't meet the mark without getting a little smarter.

What's Next

A number of new and emerging technologies can be used to power farms with data and to automate labor. For example, moisture sensors can continuously monitor the moisture level of soil and communicate with an irrigation system to increase the water supply. Editing the genomes of seeds can allow them to flourish, even in unpredictable weather conditions–which are becoming more frequent. It can also match seeds to specific soil types, to generate an optimal crop of vegetables. Advancements in agricultural drones will, in the near-future, assist with planting, harvesting and pest control.

Watchlist

UN Food and Agriculture Organization; USDA; Tyson Foods; Alico Incorporated; Agria Corporation; Adler Seeds; American Vanguard; Monsanto; Dow Chemical Company; University of Maryland; Purdue University; Iowa Farm Bureau; OpenAg Initiative at MIT; DNV GL; Cargill; Alltech; Bernard Matthews Farms; BASF; AVEBE; Archer Daniels Midland; Marrone Bio Innovations; Syngenta; Honeywell; DuPont.

SECOND YEAR ON THE LIST

Terraforming

156

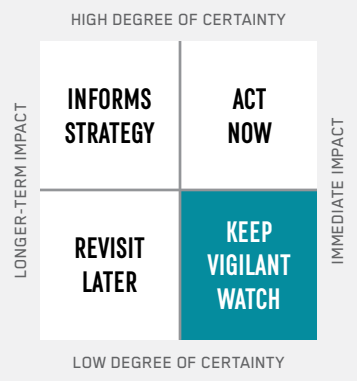


Photo courtesy: NASA.

NASA is already studying terraforming on surfaces far away from Earth.

Key Insight

Terraforming–literally, "Earth shaping"–is a concept from science fiction. People reform another planet to make it resemble Earth, so that it can support human life.

Examples

The average temperature on Mars is -67 ˚F, which might have seemed like an obstacle before the winter of 2017 when Mount Washington, New Hampshire recorded a wind chill of -90 ˚F. (Sci-fi, meet reality.) Some people believe that human life is unsustainable on earth in the far-future, and that humans will need to colonize another planet in order to survive. In September 2016, Elon Musk, CEO of SpaceX, delivered his plan to both get us to Mars and to terraform it once we arrive. It will be several years before humans pack up and move to space–but NASA has already moved ahead on several projects to study terraforming the Moon.

What's Next

The keys to terraforming could be in our current microbes, which are capable of surviving harsh environments like the Atacama Desert. Of course, we might even invent entirely new forms of life using synthetic biology. In order to advance terraforming from theory to reality, we'll need a host of new robots capable of being trained to mine for resources and build an ecosystem that can sustain human life. And we'll need powerful rockets that can power spacecraft to transport those robots to space so that they can break ground.

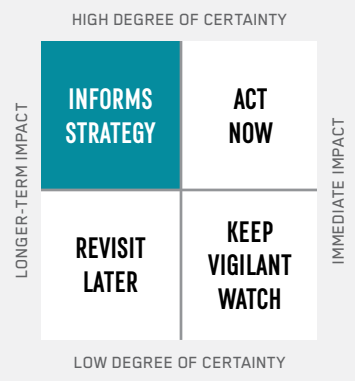
Watchlist

NASA; SpaceX.

FIRST YEAR ON THE LIST

Cultivated Food and Beverage

157



This chicken was grown in a lab and prepared by chefs in a traditional kitchen.

Key Insight

Say goodbye to tofu imitations of traditional meats. Scientists are getting closer to culturing meats and beverages in a lab.

Examples

In 2013, the **University of Maastricht** introduced the world to the first lab-grown hamburger patty, and it cost $330,000 to create. Since then, a number of startups have been working on various techniques to culture–rather than harvest–meat that has the same chemical structure as what would have otherwise come from an animal. Within just a few years, we should be able to buy lab-grown meat in the U.S.

What's Next

The clean meat movement is heading towards **acellular agriculture**, which doesn't require starter cells extracted from muscle biopsies, and brews meat from microbes. This will allow researchers to someday cultivate milk, chicken and eggs. Last year, **Impossible Burger** launched at restaurants in New York City–it's a meat patty grown using plant materials, and consumers report that they really can't tell the difference. **Finless Foods** is working on a lab-grown fish product. It will be 10-15 years before producers are able to scale production to meet our demand, but by that time we might be printing our own hamburgers at home.

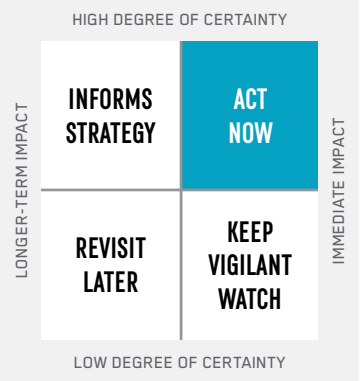
Watchlist

Clara Foods; Hampton Creek; SuperMeat; Finless Foods; Memphis Meats; Impossible Burger; Future Meat; Just; University of Maastricht; EU; FDA; the governments of China, Israel, the U.S., Japan and EU.

BIOTECHNOLOGIES, GENOMIC EDITING AND BIOINTERFACES

FOURTH YEAR ON THE LIST

GENOME EDITING



158–167

Key Insight

Biology is one of the most important technology platforms of the 21st century. Advancements in genome editing will have a profound affect on all living things, potentially helping us to live longer, healthier lives.

What You Need To Know About Genome Editing

Genome editing is a quickly-developing, game-changing field promising to influence the future of life on our planet. Mapping the human genome has been a long and difficult process. Recently, sequencing technology has become more accessible and affordable to research labs, which would enable them to work towards personalized medical treatments for vexing diseases like cancer.

Eight years ago researchers unveiled a gene editing technique called **CRISPR-Cas9**, which allows scientists to edit precise positions on DNA using a bacterial enzyme. New technologies make CRISPR gene editing more affordable. The implications are tremendous. Mosquitoes carrying malaria could be edited so that they no longer carry the disease through future generations, and so that millions of humans in high-risk regions no longer suffer from the disease. There are therapeutic possibilities in human medicine as well. Editing our genetic code could mean eradicating certain genetic diseases–like cystic fibrosis–so they can't be passed along to future generations. Liver cells could be edited so that they lower the bad cholesterol levels in families that have inherited mutations.

In 2017, there were a number of important advancements–as well as a paper that showed the potential limits of CRISPR. The first human embryos in the U.S. were modified using CRISPR at **Oregon Health and Science University**. Researchers successfully corrected a genetic mutation causing a deadly heart condition. World-renowned geneticist George Church and

his team used CRISPR to modify pig organs, making them safe to be used for human liver, kidney, heart and lung transplants. Meantime, researchers at Stanford University found that some people could be immune to part of the CRISPR process. One of the primary tools used, Cas9, is created typically using the same bacteria that cases strep throat. Some people have immune systems that are capable of naturally fending off infections, and this research calls into question whether the CRISPR technique could be effective across all–or just part–of the human population.

Throughout 2018 and 2019, we will see a number of companies further develop biological technologies. However, this is another example of an emerging technology that's developing faster than our ability to have meaningful conversations for the future. Genome editing warrants meaningful planning, as it could alter life for millions of people around the world.

Types of Genome Editing:

CRISPR-Cas9

What it stands for: Clustered Regularly Interspaced Short Palindromic Repeat or CRISPR. Cas9 is an endonuclease used an RNS-guided gene-editing platform–it's a bacterial process.

ZFN

What it stands for: Zinc Finger Nucleases. They're engineered DNA binding proteins that can introduce a break at a designated location.

rAAV

What it stands for: Recombinant Adeno-Associated Virus. It allows researchers to precisely target and edit any cell. Scientists are now working on a hybrid CRISPR-rAAV biological editing platform.

Language Matters:

- **Gene-edited and GMO:** gene-edited means that an organism's native genome has been edited, while "genetically modified organism" (GMO) means that foreign DNA sequences have been introduced into an organism.
- **Gene drive:** this is the practice of pushing the inheritance of desired genes through generations in order to permanently alter the entire population of an organism.

Geneticist George Church and his team used CRISPR to modify pig organs.

FUTURE SCENARIOS: PROMISES AND CONCERNS

Amy Webb

VERY NEAR-TERM
Pest Control vs Ecological Weaponization

Genome editing can be used in mosquitos, which carry malaria—that disease kills millions of people worldwide each year. The technique alters a section of the DNA, making it impossible for future generations to spread malaria to humans. However, some security experts warn that the same process could be used in reverse—to rapidly spread a biological weapon that could be impossible to stop.

10 – 15 YEARS AWAY
Longer Lifespans vs Overpopulation

Some argue that genome editing could be used to give humans longer lifespans and to lower mortality rates—which would result in a devastating strain on our global supply of food and greater environmental degradation. On the other hand, genome editing is also being researched to create heartier plants and double-muscled livestock for human consumption.

20 YEARS AWAY
Healthier Babies vs Super Humans

Genomic editing will someday help eradicate heritable diseases—like cystic fibrosis, Tay-Sachs disease, Huntington disease, Leigh Syndrome—from the population. The same techniques could be used additively, tweaking our musculoskeletal composition and I.Q. Very wealthy parents might be offered options to edit and enhance their future children. On a grander scale, this technology could be attractive to world leaders who play the long game in geopolitical power. Developing a population of Super Humans—physically strong, mentally powerful—would be a huge strategic advantage.

159

Biological DVRs

DNA is where we store all of our information, but the problem is that sometimes we humans have temporarily-varying biological signals. Researchers at **Columbia University** have discovered that it might be possible to record and store information about cells as they age. The technique—a sort of biological DVR—can be recorded by the CRISPR-Cas system over a period of days. In the future, this could allow researchers to very closely study how, exactly, we age. If we can quantify aging at a cellular level, maybe we can reverse it.

160

Human DNA-Powered Devices

It's relatively simple to design and fabricate a new product using computer-assisted design software and a 3D printer. Some are hoping that in the near-future, it'll be just as simple to design and build new medicines and therapeutic treatments at a molecular scale. Researchers are now working on building programmable devices out of our DNA, RNA and proteins. These molecular programs would allow doctors to "talk" to our cells in order to diagnose complex diseases, or to test new treatments. **Asimov**, an **MIT** startup, is developing a set of biological tools that would allow you to build a sort of biological circuit board. A team at **Harvard University's Wyss Institute** is researching this fantastical-sounding technology for its practical uses, like curing cancer.

161

Using Our DNA As Hard Drives

To date, scientists have stored a $50 Amazon gift card, an operating system and a film (L'arrivée d'un train en gare de La Ciotat, a short black-and-white French film made in 1896) on human DNA. Researchers at **Columbia University** and the **New York Genome Center** think that DNA could potentially be used in advanced computer systems. They're not alone. The **U.S. Defense Advanced Research Projects Agency (DARPA)** announced its own DNA storage project in 2017. It seems like a weird branch of biological science, but there are practical reasons for human computing: DNA could solve our future data storage problems. It's durable (evolutionary scientists routinely study DNA that is thousands of years old to learn more about our human ancestors). It's ubiquitous. And it's cheap, even if the current process is cost-prohibitive.

162

Nanobot Nurses

Tiny robots capable of delivering medicine to only a specific area of the body, or assisting with micro-surgery, are on the horizon. **Caltech scientists** developed an autonomous, molecular robot, made of a single strand of DNA, that treats the inside of the human body like a distribution warehouse. The nanobot can walk around, pick up molecules, and deposit them in designated locations. Scientists have been working on nanobot technology for the past decade. Researchers at the **University of California San Diego** proved in 2015 that a nanobot, propelled by gas bubbles, successfully delivered medicine inside of a live mouse without causing injury. The hope is that someday soon, nanobots will replace one-size-fits-most medications and therapies, treating our specific ailments without causing side effects.

163

Custom-Crafted Microbes

Synthetic biology is an emerging field that builds new life: replacement organs and soft tissue, as well as entirely new kinds of organisms never before seen on Earth. Synthetic biologists at **Ginkgo**

The CRISPR editing process.

Bioworks build custom-crafted microbes for their customers, which have included designer bacteria enabling crops to fertilize themselves. **Zymergen** is developing original microbes for making specialty polymers, which have applications in military equipment and electric vehicles. The **University of British Columbia-Okanagan** is developing realistic human hearts that can be used for surgical trainees.

Biology is quickly emerging as one of the most important technology platforms of the 21st century.

GENOME EDITING CONT.

164

Precision Medicine Just For You

This is a new approach to personalized treatment and prevention, allowing doctors to design a treatment strategy using our own genes as guides. In the future, there would no longer be a single medication for all, but rather an individualized treatment for each one of us individually. The market for precision medicine is enormous, attracting new partnerships between corporate behemoths. In January 2018, **GE Healthcare** and pharma-giant **Roche** announced a joint venture to co-develop precision medicine products for cancer and critical care. In the U.S., the **National Institutes of Health** created **All of Us**, a national program aimed at gathering data from one million Americans to help accelerate precision medicine advancements.

165

Running Out Of Space For Genome Storage

One of the fastest-growing datasets in the world is made up of our human genetic data. By 2025, researchers at the **University of Illinois at Urbana-Champaign** estimate that we may be out of data storage space for human genomes. As precision medicine, **CRISPR** and gene therapy technologies continue to advance and improve, our storage needs will explode along with the computing power and requirements for acquiring, distributing, analyzing, encrypting and safeguarding our genomics data. As technology becomes increasingly intertwined with biology, we're realizing that we didn't plan ahead for adequate storage capacity, and that we didn't create good technology workflows for storing all that data. Australia's **Garvan Institute of Medical Research** is looking into different processes and workflow to reduce the genomic data footprint going forward.

166

Genome Editing Research Clashes With Public Opinion

In China, human CRISPR trials have been underway for several years. **Sichuan University** began testing modified cells on people with lung cancer as early as 2015, while in Guangzhou, researchers from **Sun Yat-sen University** published the results of their tests on human embryos in 2016. All of these stories raised concerns for ethicists and biologists in other countries, and yet we still have no global norms or a global agreement detailing how we should experiment with and use emerging biological technologies. In the U.S., U.K. and Europe, CRISPR trials will begin in earnest during 2018. As the results of trials are published, we expect some amount of public outcry, which could lead to the spread of misinformation, eventual calls for regulation and the stifling of research and funding. There's precedent for our forecast: remember Dolly the sheep?

167

Nootropics and Neuroenhancers

In the next few years, a number of drugs (also called "**nootropics**") and devices, intended to enhance our cognitive ability and manage stress, will be made available to the public.

Nootropics are dietary supplements that have been shown to improve cognitive function—even if they're not officially regulated or approved by the FDA. Bacopa monnieri, panax ginseng and ginkgo biloba are all being marketed to help promote mental clarity, focus attention and retain information.

Neuroenhancer devices are intended to record brain waves and send feedback. Some promise to help you become more productive, while others are meant to boost your mood. **Australia**-based **SmartCap** is a tracking system that uses voice warnings and vibrations to keep you alert while on the job. **Canadian** startup **InteraXon's Muse** headband uses neurofeedback to help manage stress and improve athletic performance. The **Emotiv Epoc+** and **Emotiv Insight** and mobile EEG devices monitor your brain activity and analyzes cognitive performance. **Doppel**, which is worn on the wrist, uses electric pulses to augment your energy. The pulsations, which you dial in based on your needs, are supposed to have a similar effect on your brain as music does. **The Thync Kit** is a series of electrodes and a triangular device that you stick on to your head—and a mobile app synching you to your smartphone. It delivers low-grade electric pulses to influence either your sympathetic (fight or flight) or your parasympathetic (rest and digest) nervous system.

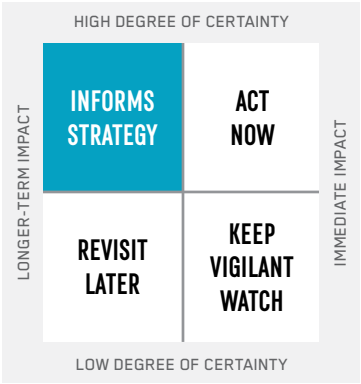
And for those who want to get more meta: South Korean startup **Looxid Labs** is building a headband to gather metrics while you're on nootropics or wearing neuroenhancer devices. It promises to collect all the data necessary to tell you whether or not you actually relaxed.

Scientists stored French movie *L'arrivée d'un train en gare de La Ciotat* in DNA.

FIRST YEAR ON THE LIST

Microbiome Extinction

168



Researchers now think that we're causing the extinction of a large potion of the human microbiome.

Key Insight

We may all be guilty of causing a mass genocide, which is happening right now, in our guts and in the environment. The widespread use of antibiotics, along with diets rich in processed foods, have led to a staggering decline of microorganisms in wealthy nations.

Examples

During the past 12,000 years of human evolution, we've shifted nature's balance—our diets are relatively narrow, compared to our far-distant ancestors. Recently, scientists studied modern hunter-gatherer tribes in **Tanzania**, **Peru** and **Venezuela**, whose microbiota have 50% more bacterial species than people do in the West. Unlike those tribes, we no longer hunt and eat wild flora, fauna and animals. Those from wealthier countries now eat very little dietary fiber, limited variety of fruits and vegetables and only four species of livestock: sheep, poultry, cattle and pigs. Our microbiomes are shrinking.

What's Next

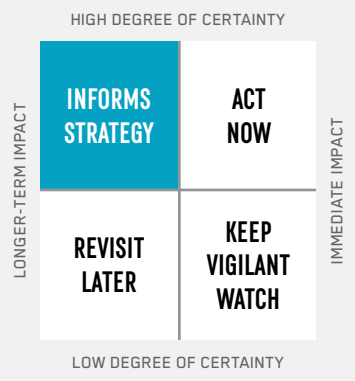
We humans are complex, composite organisms, made up of layers and layers of cells. Researchers now think that our gut microbiome is directly linked to everything: our metabolism, immune system, central nervous system, and even the cognitive functions inside our brains. It's an inherited problem: most of our microbiota are passed from our mothers through the birth canal. There are a number of researchers now looking at the future of our microbiomes. San Francisco-based startup **uBiome** has launched several at-home microbiome tests (though you still need a subscription to take one). **The American Gut Project**, the **American Gastroenterological Association** and **OpenBiome** will track 4,000 patients over 10 years to learn about fecal microbiota. Investors have poured more than a billion dollars into microbiome startups since 2016. It's a field that's also attracting talent: last year, **IBM Watson's** former head of AI research **Guruduth Banavar** left to join startup **Viome** as its chief technology officer.

Watchlist

Microbiome Center at the University of Chicago; Stanford University's Sonnenburg Lab; Viome; SENS Research Foundation; uBiome; U.S. Food and Drug Administration; University of Pennsylvania; the American Gastroenterological Association Center for Gut Microbiome Research & Education; The American Gut Project; OpenBiome.

FIRST YEAR ON THE LIST

Building A Comprehensive Human Cell Atlas



The Human Cell Atlas team will create the first map of all the cells that make up the human body.

169

Key Insight

Researchers are working on the first-ever comprehensive map of all of the 37.2 trillion cells that make up the human body.

Examples

A large team of scientists–including 130 software engineers, mathematicians, computational scientists, biologists, clinicians and physicists – hailing from **Israel**, **the Netherlands**, **Japan**, **the U.K.**, **the U.S.** and **Sweden**, are hard at work mapping the human body on a cellular level. Although a cell atlas had long been theorized, new biological tools and more compute power have turned this one-time vision into a reality.

What's Next

The team working on the atlas believes that they can draw comprehensive reference maps for all human cells in the body. A human cell atlas would give the medical community a new way of understanding how our bodies work and how to diagnose, monitor and treat disease.

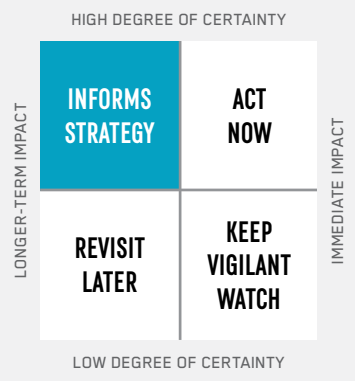
Watchlist

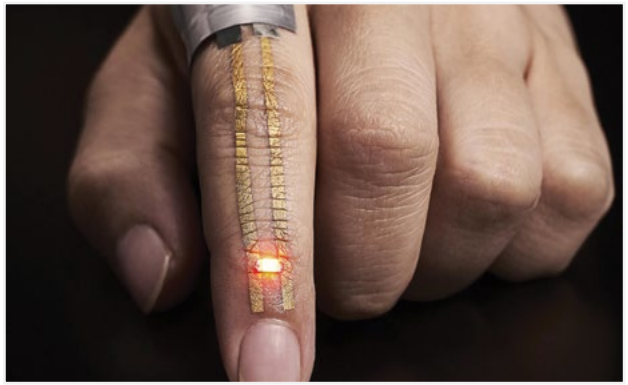
The organizing committee and academic institutions of the Human Cell Atlas.

FOURTH YEAR ON THE LIST

Biointerfaces Laminated Onto Our Skin

170





The Takao Someya team at the University of Tokyo is testing ultra-thin wearable biointerfaces.

Key Insight

Ultrathin electric mesh, pressure-sensitive fabrics, optical sensors and bio-acoustic sensing arrays will soon provide a persistent window into your health.

Examples

Tiny, temporary biointerfaces that include biochemical, light-based and electrical sensors could allow us to use our bodies in entirely new ways. Biointerfaces could someday be used to monitor our vital signs, blood sugar levels or even provide persistent connections between our bodies and the physical world. Researchers at **South Korea's Daegu Gyeongbuk Insistute of Science & Technology (DGIST)** and at the **University of Tokyo** in **Japan** are testing ultrathin, gas-permeable sensors that can be directly laminated onto human skin for long periods of time. This could enable doctors to continuously monitor their patients, or even patients to monitor themselves.

What's Next

Biointerfaces are being tested for medical purposes, but there are communication applications as well. Researchers at the **Design Lab** in **Berlin** have developed a glove that has embedded pressure sensors, which could soon give the gift of limitless communication to deaf-blind people, who currently rely on a system of tactile (hand-to-hand) sign language. Software translates the sign language alphabet into digital text and is connected to the Internet–meaning that anyone will be able to communicate freely with people who are deaf-blind.

Watchlist

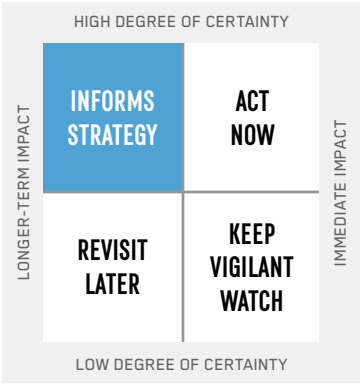
Daegu Gyeongbuk Insistute of Science & Technology; University of Tokyo; MIT; Stanford University; Design Lab; Carnegie Mellon; University of Michigan; University of Pennsylvania's Nano/Bio Interface Center; the Center for BioInterface Resarch at Georgia Tech.

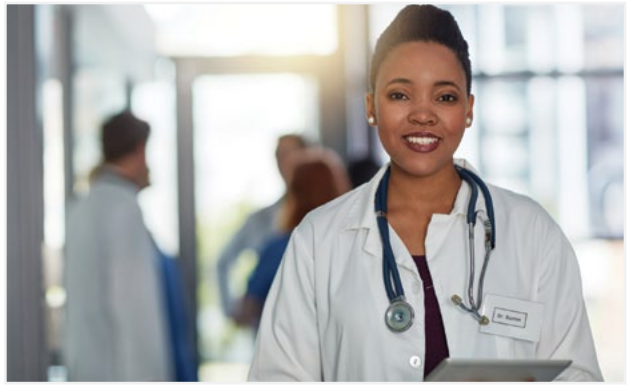
HEALTH TECHNOLOGIES AND WEARABLES

SECOND YEAR ON THE LIST

Patient-Generated Health Data

171





The doctor will see you—and your smartphone—now.

Key Insight

Patients are creating a trove of data that could contribute to their healthcare provider's overall assessment. Packaging all that data—and figuring out how to make use of it—is still a challenge. So is making sure it's secured.

Examples

As of this report's publication date, the key provisions of the **Affordable Care Act (ACA)** were being debated in congress, while the **Trump Administration** continued in its efforts to dismantle the program. Even if the ACA is repealed, all of the electronic medical records systems that were put in place to meet compliance regulations, are likely to stay.

Anytime we visit a doctor's office, all of our health data is filed electronically. We're also creating troves of health data via our fitness trackers, cars, smartphones and watches, which monitor our behavior. All of this data has to be stored, and the medical community and public health sector are now trying to find ways to make good use of what we're creating. Differential privacy measures could enable hospital systems to anonymize our private details while still making our data useful to researchers. New software from companies like **Validic**, allow doctors to collect this other data and incorporate it into their medical records—as long as patients give their consent. **GE Healthcare**, **Meditech**, **Allscripts**, **eClinicalWorks** and **Cerner** are all building products to make better use of our data.

What's Next

Healthcare systems and providers will need to shore up security fast. On a near-weekly basis, hackers are targeting hospitals and doctors, holding patient data for ransom. In May 2017, hackers used the **WannaCry** malware to break into the **U.K.'s National Health Service**, crippling the nation's hospitals and clinics. In January 2018, hackers used the remote access portal to break into a rural Indiana hospital. They demanded 4 bitcoin to release the data. The timing was awful: there had just been a serious ice storm, which caused a spike in emergency room visits, and there was a local flu outbreak.

Not all future scenarios are bleak. Our health data, combined with artificial intelligence, could soon allow doctors to provide us better preventative care.

Watchlist

GE Healthcare; Meditech; Allscripts; eClinicalWorks; Cerner; Validic; HumanAPI; Vivify; Apple; IBM; Microsoft; Qualcomm; Tactio; Alphabet; Medicare; Medicaid; national health systems; insurance companies.

SECOND YEAR ON THE LIST

Touch-Sensitive Prosthetics

172

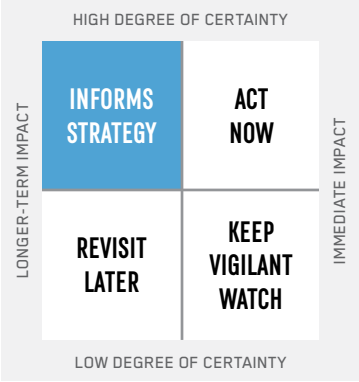


Photo courtesy: Ortiz Catalan et al., Science Translational Medicine

In the near-future, prosthetics will both move and communicate the sensation of touch.

Key Insight

Researchers are developing new prosthetic limbs that restore not just movement–but touch as well.

Examples

Humans are capable of distinguishing between various surfaces–and we're quite sensitive. Researchers have been amassing a body of knowledge to help them develop electronic skin, and prosthetic body parts that deliver haptic, tactile sensations.

What's Next

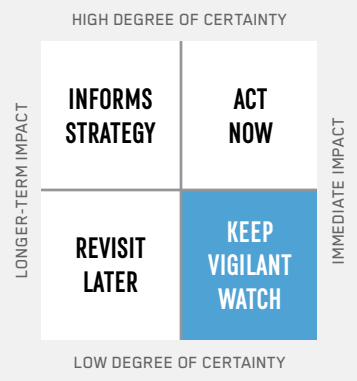
Interdisciplinary researchers at the **Center for Wearable Sensors** and the **Center for Brain and Cognition** at the **University of California at San Diego** are combining materials science, and psychophysics, to map exactly how humans perceive touch. This research lays the groundwork for advanced prosthetics in the future. We've already seen some exciting developments. Neuroscientists at the **University of Chicago** are experimenting with touch-sensitive robotics and rhesus monkeys, whose neural-sensory biology is most similar to humans. They successfully simulated the sensation of touch by stimulating certain areas of the brain. A team of scientists from the **Lausanne and Sant'Anna School of Advanced Studies** and the **University Hospital Agostino Gemelli** developed a bionic hand that transmits a realistic sense of touch; it's already in use, restoring sensation to a woman who lost her hand in an accident 25 years ago.

Watchlist

University of California at San Diego; Lausanne and Sant'Anna School of Advanced Studies; University Hospital Agostino Gemelli; National Academy of Science; FDA; University of Chicago; Duke University's Center for Neuroengineering; University of Southern California; University of Washington's Center for Sensorimotor Neural Engineering; Johns Hopkins University; Carnegie Mellon University; StarLab; Case Western Reserve University; Penn State University; DARPA.

SECOND YEAR ON THE LIST

Smart Thread



Smart thread can change color and transmit data.

173

Key Insight

"Smart thread" uses electrical currents and transmits information to doctors after surgery.

Examples

Think of "smart thread" as a sort of temporary, smart system that connects to a smartphone or other medical device and reports on your glucose levels, diagnoses an infection and alerts hospital staff if your body is chemically out of balance. Researchers at **Tufts University** have embedded nano-scale sensors and electronics into surgical thread, that can be used for suturing. Meantime, at the University of California at Berkeley's School of Information, researchers are experimenting with smart threads that can change color. These non-surgical threads are coated with thermochromic paint that changes color when jolted with electricity.

What's Next

Smart thread is just coming out of experimentation, but initial tests results show that it can be successfully used as a diagnostic device.

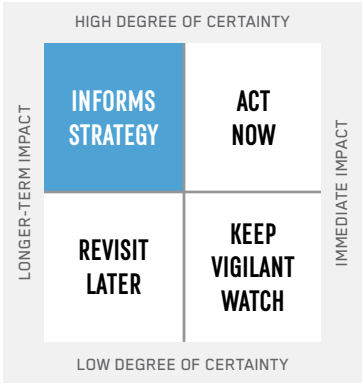
Watchlist

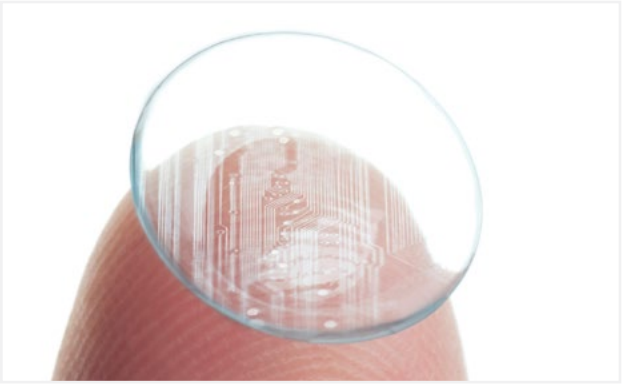
Tufts University; University of California at Berkeley's School of Information; Harvard-MIT Division of Health Sciences and Technology; Harvard University's Wyss Institute.

SECOND YEAR ON THE LIST

Bioelectronics

174





Alphabet's Verily Life Sciences is helping to bring a new branch of health science to the mainstream.

Key Insight

Bioelectronics is a new scientific field in which tiny, ingestable and implantable devices are used to treat a variety of ailments.

Examples

Stanford University's School of Medicine is researching biosensors that could help us predict when we're about to get sick. One of the doctors involved in the project became his own research subject. On a flight to Norway, he noticed a change in his heart rate and blood oxygen levels, though he wasn't symptomatic. Remembering that a few weeks earlier, he'd been in rural Massachusetts, he decided to find medical attention as soon as he landed. It's a good thing he did: the biosensors picked up Lyme disease well before he'd have otherwise known he was infected.

What's Next

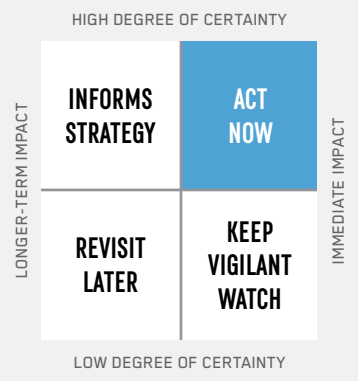
Alphabet's Verily Life Sciences is partnering with a lot of health-tech and pharmaceutical companies to develop new products. Its venture with glucose monitor maker **Dexcom** could lead to a new kind of continuous glucose monitor. Verily is working with contact lens maker **Alcon** to create smart contacts that both correct our vision and monitor our blood sugar. Already, **Verily** and **UCLA** have developed a wearable microscope that can be used to detect certain kinds of cancers. Just as complex computer networks can be analyzed and fixed by isolating specific nodes–bioelectrical engineers believe that the human body can be similarly addressed to stimulate our immune system, slow the progression of disease and extend human longevity.

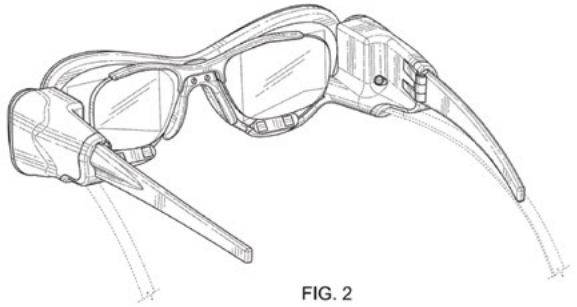
Watchlist

Alphabet's Verily Life Sciences; Stanford University School of Medicine; Alcon; Dexcom; IBM; GSK; 3M; AstraZeneca; University of California Los Angeles; Novartis.

SIXTH YEAR ON THE LIST

WEARABLES





Magic Leap's new MR glasses will sent to developers in 2018.

175-188

Key Insight

As of January 2018, the Future Today Institute is tracking **538 wearable devices**, in various stages of development–from fringe experimentation to mass-market sales. The **Future Today Institute** estimates that by the end of 2018, **345 million wearable devices will be sold worldwide**. More than half are dedicated to fitness or biometrics, while others are intended for gaming, work and medical monitoring. Global sales should generate revenue of $38 billion in the coming year.

As of now, nearly all wearables require a smartphone or computer to see and report data, adjust settings and archive information. Those coming to market in 2018 and 2019 will continue to service our fitness and lifestyle needs with our mobile phones as a hub.

176

Smart Glasses

This will be the year that developers start experimenting with **Magic Leap**, whose smart glasses project light directly into the user's eye, making it seem as though digital objects exist in the real world. Don't force connections between **Google Glass** and what comes next. Glass was a successful technology in search of a market.

177

Hearables / Earables

In-ear computers, otherwise known as earables, are here. **Bragi's** wireless **Dash** earbuds give users access to Android's and Apple's digital assistants, responding to gesture as well as voice. For example, an incoming phone call can be accepted by shaking your head yes, or declined by shaking your head no. Future versions of **Apple's EarPods** will monitor temperature, perspiration and heart rate during exercise or sports–and those earbuds will be used to control electronic devices (like our phones) using head gestures.

178

Head Mounted Displays

Virtual reality headsets are wearable devices. What's next: they will soon collect your biometric data and other personal information in order to provide added functionality. The **HTC Vive** tracks your movement, while controller sticks send haptic signals to your brain as you work your way through simulated environments. Beyond videos, there is not much additional opportunity to integrate news with HMDs.

179

Smart Bras

Smart bras, intended for athletes and fitness enthusiasts, captures biometric data to track cardiac and pulmonary activity. One startup, **OMsignal**, created a smart bra that creates an individual baseline for the user, then monitors activity looking for abnormalities. The system can detect early signs of pulmonary conditions and sleep apnea.

180

Smart Helmets

The National Football League and Air Force both use smart helmets, but now that technology is coming to everyday people. **Islamabad**-based startup **Let's Innovate** has developed a smart motorcycle helmet that automatically calls for an ambulance in case of emergency. Nearly half of Pakistani households own motorcycles, but only 10% of riders wear helmets—and about 15 people every day die in motorcycle accidents. A smart helmet capable of calling for help could save lots of lives in Pakistan, not to mention in other areas around the world.

181

Smart Gloves

Canadian researchers at **Simon Fraser University** designed a set of interconnected gloves to help transmit a sense touch through the internet. When someone moves her fingers in one glove, her actions are sent to her partner wearing the other. **Sony** has been filing patents for haptic glove controllers, which would simulate the physical sensations of slicing, punching and shooting.

182

Tattooables

Medicine will start to look very different. **Tattooables**—temporary skin that can store data and deliver drugs—have entered trials. Researchers at the **Institute for Basic Science** and **Seoul National University** in South Korea, the **University of Texas** in Austin, the **University of Tokyo**, **Stanford** and the **University of California at San Diego** are all working on electronic second skins. **MC10** has already created microscopic, organic semiconductors and carbon nanotubes that stretch and flex and can be powered wirelessly. Called BioStampRC, it's far

thicker than a tattooable, but the idea is the same–and it's only a matter of time before the technology shrinks.

183

Thinkables

Thinkables will soon allow more adventurous gamers to control games using only their thoughts. Boston startup **Neurable** created a brain-controlled VR game called ***Awakening*** that lets you control the game with your thoughts. The **4D Force** platform detects brain waves, capturing EEG/ EOG/ EMG signals and converting them into signals a computer can understand.

184

Ingestables

In the next few years, we'll see several new ingestible and implantable devices that deliver drug therapy, monitor our vital statistics, stimulate our brains, help manage pain and bladder control and more. (See also: Advanced Robotics and Genome Editing sections.)

185

Smart Fabrics

A new breed of **weavables** and **connected fabrics**–textiles woven with sensors and other technologies–will provide haptic feedback for a number of practical purposes. Japan-based Xenoma created a set of smart pajamas for people suffering from dementia. It would offer patients greater freedom of movement by geofencing them in a designated area, without needing to confine them to hospital rooms. Apple is researching smart fabric watch straps and other kinds of interactive garmets, which would sync up to its Health App. There may be other projects in the works–recent European patent filings show that Apple is researching smart fabrics for wallets, arm bands and cushions. **Google's Project Jacquard** partnered with **Levi's** and launched a smart jacket, which it's now selling in retail locations around the U.S. **Biofabricate** is growing fabrics in a lab. Projects in the works include drug-releasing medical textiles and fabrics that regulate moisture in our skin.

186

Smartwatches

There are lots of smartwatches now in the market, though Apple dominates sales worldwide. In 2017, Samsung, Fitbit and Garmin all released new models, and we anticipate even more launches in 2018. Luxury brands like **Louis Vuitton**, **Cartier**, **Tiffany**, **Armani**, **Tag Heuer**, **Bulgari** and **Montblanc** are now getting into the business, launching on the **Android** platform.

187

Smart Shoes

In early 2018, **Baltimore**-based **Under Armour** launched its next-generation set of connected running shoes, whose foam soles include an accelerometer, a gyroscope, a battery and a Bluetooth module. The shoes collect and store data, allowing you to go out for a run without having to bring along your smartphone. They also set a baseline the first time you use them, and then track distance, stride length and your running cadence over time. Others in the market include **Altra IQ** for fitness, **Orphe** for light shows at night, and **Solepower** to generate power for your cell phone while you hike.

Bragi's hearables double as digital assistants.

188

Wireless Body Area Networks

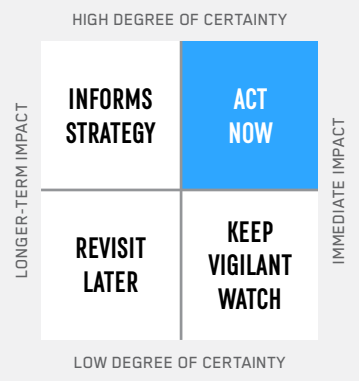
Wireless Body Area Networks (**WBANs**) communicate information from your wearable devices back to medical servers, app manufacturers and your home computer. Sensors, such as devices to monitor your heart rate or oxygen level, collect data and send it back to a central hub (most often, your smartphone) which then relays the information to a medical team or health care monitoring service. There are a lot of benefits: rather than moving into an assisted living facility or spending a lot of time in the hospital, patients can instead move back home while being provided with virtual care. While some of the established medical devices use strong encryption algorithms, many new wearable devices don't. They're sending a lot of unencrypted, unsecured personal data – including our locations – across the Internet. As the hacking community becomes more sophisticated, it's started targeting hospitals and clinics. The **U.S. Department of Homeland Security** has been investigating several cybersecurity cases related to WBANs.

SMART HOMES AND THE INTERNET OF THINGS

SIXTH YEAR ON THE LIST

Privacy Laws, Net Neutrality and Hackers Threaten the Internet of Things

189



Key Insight

FTI has been tracking the evolution of the Internet of Things (IoT) for a decade. This year, we see a convergence pitting the IoT's growth against the serious challenges posed by hackers and policymakers.

Examples

Billions of smart sensors and devices in our homes, offices, schools and cars are talking to each other, monitoring information and activity, and automating tasks in order to make your life easier. These devices and their protocols make up the Internet of Things (IoT). In the next few years, there could be as many as 30 billion connected devices and machines online: fitness trackers, traffic lights, bras, autonomous vehicle components, farm equipment, parking meters, coffee machines, personal drones, shoes, doorbells, fish tanks, bicycles, pajamas–we could fill another hundred pages of this report just listing the diverse ecosystem that will soon become the IoT.

Why the sudden explosion? It has to do with the sharply-decreased cost of components, sensors, bandwidth and processors–as well as the now-ubiquitous availability of smartphones and WiFi in industrialized nations. Even the internet itself got an upgrade to something called **Internet Protocol Version 6 (IPv6)**, which is helping to expand the IoT so that there are enough usable addresses to go around. International standards organizations are working on a future open standard, just as HTTP and FTP play critical roles in how we move content around on the web today.

What's Next

New privacy laws in **Europe** and net neutrality rollbacks could seriously impact all of this progress. Once the **General Data Protection Regulation (GDPR)** goes into effect, it will change how devices can collect and use human data. It's unclear whether a smart thermostat in someone's home will meet compliance standards once the regulations are in place. Now think of all the billions of devices that rely on human-generated data, or that send data with personal attributes back to us through mobile apps–that could be a catastrophic compliance problem with no immediate solution. Meanwhile, in the **U.S.**, if **internet service providers** are legally allowed to throttle access and speed, it could cause latency and hiccups in our connected devices. This could frustrate **Alexa** and **Google** Home users–conversations with digital assistants could face constant interruption and lag. But it also means security risks for everyone. If you're away from home and a smart smoke detector sends you a notification that your garage is on fire, you–and the fire department–would want that message right away. If our ISPs determine which accounts, services and devices get priority, that could spell disaster.

Securing the IoT will continue to be a challenge in the coming year. IoT devices are considered ideal targets, because consumers are purchasing more and more connected devices without also learning about how to secure them. Just as your computer can be hijacked by a botnet, so can your smart doorbell. In October 2017, researchers at **Netlab 360** found the **IoT_reaper botnet**, which was infecting an average of 10,000 new devices a day. In 2016, the **Mirai botnet** infiltrated tens of thousands of DVRs and

The Mirai botnet infiltrated tens of thousands of DVRs and webcams, which helped it successfully take down a large swath of the internet.

webcams, which helped it successfully take down a large swath of the internet.

There will be calls for increased security and regulation in the coming year, when the IoT nears an inflection point—and development starts to outpace our ability to secure it.

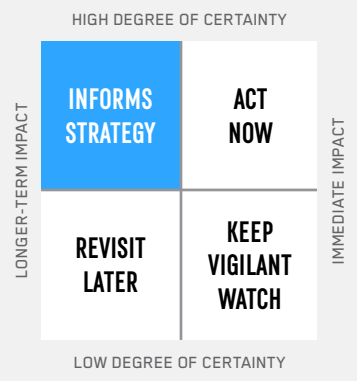
Watchlist

Qualcomm; Cisco; Symantec; Bitdefender; Global Cyber Alliance; Alphabet; Amazon; Apple; Honeywell; IFTTT; GE; Intel; Cisco; IBM; Sony; Samsung; LG; Hadoop; Arduino; SmartThings; AT&T; Verizon; Ericsson; Atmel; littleBits; National Cybersecurity Alliance; European Union; U.S. Congress; Federal Communications Commission; Federal Trade Commission; internet service providers.

FIRST YEAR ON THE LIST

Searching The Internet of Physical Things

190



The Internet of Things is becoming easier to search.

Key Insight

The Internet of Things—that massive interconnection between all of our smart devices and the internet—is growing at breakneck speed. We already have billions of physical devices connected to the internet, but what about also searching for real-world things?

Examples

Several years ago, **Amazon** updated its mobile app to allow people to shop for real-world objects by scanning their barcodes. Its next iteration let users take and upload a photo. Now, you only need to wave your smartphone near an object you want to get more information on, or you can directly add it to your shopping cart. Online search giants like Google and Bing have made it easy to find just about any information in the digital realm. The idea is to let us search real-world objects, as well as all of the devices connected to the Internet of Things.

What's Next

Shodan and **Thingful** are search engines for IoT devices. It was intended as a security tool to help IT professionals keep track of all the devices connected to a network—but hackers also found that they could remotely access baby cameras and garage doors. **German** lighting manufacturer **Osram** built a tiny chip that can scan a bar of chocolate to determine how much cacao is inside. Its chip helps power a consumer-grade molecular spectrometer built by Israeli startup **Consumer Physics**, which allows anyone to extract information out of food and pills. This could enable you to scan a piece of chicken in order to search the fat and calories on your plate. Their research is also able to recognize prescription and over-the-counter drugs in order to spot counterfeits. Osram expects that there will be consumer products able to search the physical world launching in the next few years. Meantime, **MatchMaker Exchange** is an "Internet of DNA," matching the DNA from sick people around the world to help researchers discover rare genes. It's not unrealistic to say that in the near future, everything you see (and even the things you can't) will become searchable via a distributed network. But what if the real-world gets hacked? It's possible that someone could re-label contaminated medication as pure. As the searchable physical IoT grows, we will need a new system to verify searches.

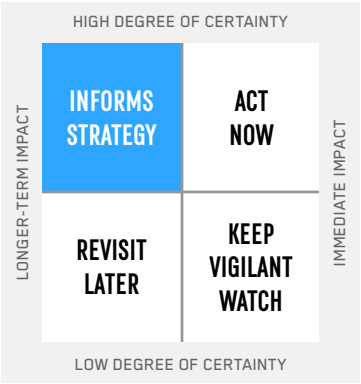
Watchlist

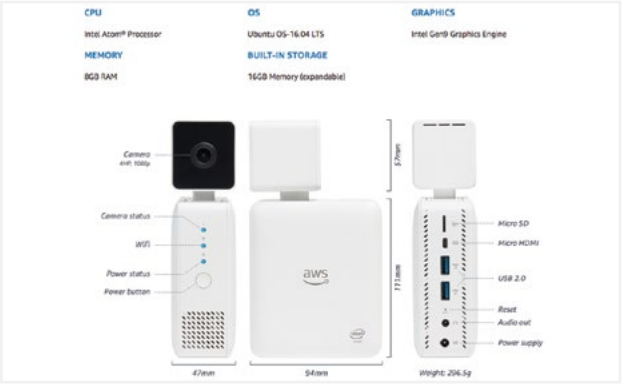
Shodan; Thingful; Qualcomm; Intel; Alphabet; Microsoft; Apple; Tencent; Alibaba; Baidu; Amazon; Osram; Consumer Physics; MatchMaker Exchange.

FOURTH YEAR ON THE LIST

Intelligent Cameras

191





Amazon Web Services launched a $250 AI-powered camera called DeepLens.

Key Insight

Cameras themselves are getting smarter, and they now have on-device AI capabilities. They are able to listen to and watch what's in the frame, then make decisions based on that information. That might include locking a door, recording a conversation, or following a robber as he runs down the street.

Examples

Late in 2017, **Amazon Web Services** announced a $250 AI-powered camera called **DeepLens** that includes optical character recognition, as well as image and object recognition. A smart camera would enable companies to remotely count and monitor warehouse inventories. They could also let conference organizers and Hollywood movie studios gauge the level of enthusiasm during performances (no more focus groups or having to beg attendees to fill out post-conference surveys!). **Google** launched **AIY Vision Kit**, a smart camera kit that works with **Rasberry Pi**–the company is hoping that DIY enthusiasts and developers will start building smart camera applications. **Yves Béhar**, who designed the **August** smart lock, created a new home security camera called the **Hive View**–it automatically sends smartphone notifications when it detects any unusual motion or sound. Engineers at the **University of Washington** have developed a system of networked cameras that can automatically track people as they move. Combined with **facial** and **object recognition** algorithms and **AI**, smart cameras will provide unprecedented security opportunities. They will be used in our cars, bringing us one big step closer to hybrid-autonomous vehicles, where drivers will choose to take control of the wheel or allow the car to drive itself during stop-and-go traffic.

What's Next

Advancements in smart camera technology are critical to the future of our AI ecosystem. Soon, they will be able to see in the dark. Recognition algorithms will do more than spot people and pets. They'll connect with other IoT devices, making autonomous decisions–like when to lock the doors, whether to close off bridge access, and which roommate gets the last slice of pie.

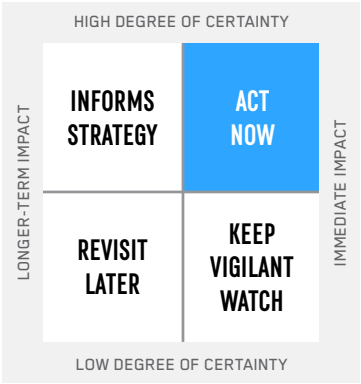
Watchlist

Amazon; Alphabet; Microsoft; Qualcomm; Intel; Tencent; University of Washington; Microsoft; Camera Culture Research Group at the MIT Media Lab; Institute of Anthropomatics & Robotics at the Karlsruhe Institute of Technology; National Instruments; Electronic Frontier Foundation; Austrian Institute of Technology; University of Birmingham.

In the near-future, smart cameras with on-device AI capabilities will connect with the IoT and make autonomous decisions, like when to lock the doors, whether to close off bridge access, and which roommate gets the last slice of pie.

THIRD YEAR ON THE LIST

SMART HOMES



Urbaneers developed a smart kitchen prototype with wireless devices and in-counter charging pads.

192-199

Key Insight

The global, addressable smart home market could top $140 billion in the next five years. Driven by lifestyle changes, energy and cost savings, we should see an increasing demand for in-home connected appliances, devices and locks.

As of now, nearly all wearables require a smartphone or computer to see and report data, adjust settings and archive information. Those coming to market in 2018 and 2019 will continue to service our fitness and lifestyle needs with our mobile phones as a hub.

192

Our Appliances Will Have Digital Assistants

Samsung announced that all of its appliances will include Bixby–the company's digital assistant–by 2020. Apple has opened up its HomeKit requirements, making it easier for manufacturers and developers to incorporate Siri. Both Amazon and Google are partnering with appliance manufacturers en masse, which will soon allow us to turn on our dishwashers and see how much time is left on the dryer.

193

Smart Appliance Screens Are Coming

Major appliance manufacturers are including smart screens in upcoming models, supported by Alexa and Google Assistant. The Samsung Family Hub smart refrigerator and Whirlpool Cabrio washing machines will allow users to interact with them via touch screens and smartphones. The smart screen interfaces offer customization–new specialty cycles and programs can be downloaded from the internet.

194

Home Appliances Will Talk To Each Other

As the **Internet of Things** matures, more of our smart home appliances will offer interoperability, resulting in more automation. For example, the **Bosch Home Connect** smart kitchen line connects to **Nest Protect**. If you forget that pizza in the oven and it starts to catch fire, your Nest smoke detector will tell the oven to turn itself off. In the coming year, we'll see more integrations across brands and appliances.

195

Wireless Kitchens

As appliances and devices start to take over our counters, we could wind up tangled in wires. That might not be a problem in the near future. Manufacturers are researching options for wireless charging, which include in-counter charging panels and more energy-efficient appliances. **Urbaneer**, a Michigan-based home furnishing designer, is working on a suite of connected furniture that can charge nearby devices.

196

Smarter Home Security

All of the screens in your connected devices will soon double as security cameras. Researchers are building new software that connect smart screen-equipped devices–such as your television, your **Chromecast**, your **Echo Show**, your refrigerator–with security systems. In practice, this means that you could remotely monitor any part of your home without having to purchase a camera for every room. **Taiwan**-based **D-Link**, which builds home networking equipment, is launching home cameras that integrate with either **Google Assistant** or **Alexa** as well as other screens in your home.

197

Smart Remotes

Subscribers to **Comcast's Xfinity** already have access to voice-controlled remote controls, which allow users to search for actors, ask questions about shows, and bypass the menu system to quickly find what they want to watch. We tend to associate remote controls just with our televisions, but you can expect to see new uses for remotes in the years to come. Startup **Flic** debuted a bottle cap-sized button that you can customize to trigger actions around your home. For example, if you want your **Amazon Echo** to play **Spotify**, just touch the button. The **Nanoleaf**, designed to work with **Apple's HomeKit,** is a modular remote control with 12 programmable buttons. As digital voice assistants become more integrated with our everyday lives, smart remotes could play a critically important role for people who can't speak due to illness or age, or whose accents prevent them from being understood easily.

198

Smart Mirrors

Want to know how you really look before you leave for the office? Several new AI-powered mirrors, capable of image and object recognition, are coming to market this year. They're more like tablets than traditional mirrors, offering beauty, fashion, news and weather app. **Haier's Magic Mirror** helps you keep track of your wardrobe and closet–not unlike Cher's famous closet computer in the movie Clueless. The **HiMirror Mini** creates a baseline measurement for your skin, and over time it tracks progress towards your goals. We anticipate a host of new smart mirror applications, which will help coordinate outfits, learn makeup and hair tutorials, assist you with flossing properly, and more. Many smart mirrors include digital assistants, which play the news and display the weather when asked.

199

Our Smarthomes Become Weaponized

We've already seen one big case of our smart homes becoming weaponized. In 2016, the **Mirai botnet** infiltrated tens of thousands of DVRs and webcams, which helped it successfully take down a large swath of the internet. In May 2017, an 11-year-old was able to infiltrate Bluetooth-enabled teddy bears. All the smart devices in our homes are considered ideal targets, because we're purchasing more and more of them–and because too often, manufacturers don't issue regular firmware updates, or they aren't proactive enough in helping consumers apply security patches.

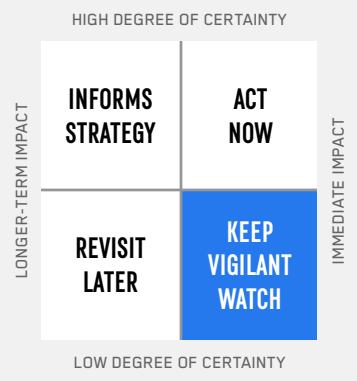
Samsung's Family Hub includes a connected refrigerator with a large touchscreen.

WORKPLACE AND LEARNING TECHNOLOGIES

SECOND YEAR ON THE LIST

Universal Basic Income (UBI)

200



Finland concludes its two-year UBI experiment at the end of 2018.

Key Insight

The idea of an unconditional guaranteed income for everyone within a country is now being discussed again both as a means of encouraging entrepreneurial innovation and in the wake of automation, advanced robotics, and artificial intelligence.

Examples

In 2016 **Finland** launched a two-year UBI pilot study, offering a randomly-selected group of 2,000 - 3,000 citizens a monthly stipend of 560 Euros (or about USD$600). Following up on the initial UBI pilot being conducted in Finland, the end of 2017 saw **Scotland** and its **First Minister Nicola Sturgeon** embrace the idea of conducting a UBI pilot locally. The proposed Scottish pilot has already generated support in the form of a £250,000 grant (about USD$346,000) to study its feasibility.

What's Next

An interesting thing to note about the UBI debate is that it has supporters and detractors from both the **liberal** and **conservative** sides of the aisle (both in the United States and internationally). For UBI optimists, this bipartisanship represents an opportunity to craft UBI policies that could be instituted legislatively.

The UBI discussion has also become more popular in **academia**, with a 53% increase in the number of articles published from 2016 to 2017 on Google Scholar. **Think tanks** have also continued to assess the economic benefits of a UBI either as a stand-alone policy or as an alternative to existing social welfare programs. With Finland's two-year experiment set to end in December 2018 and findings expected in early 2019, results of this experiment could signal how other countries approach UBI moving forward. **Silicon Valley** also remains bullish on the idea of UBI. In his 2017 commencement address to Harvard University's graduating class **Facebook's CEO Mark Zuckerburg** continued to affirm his support of a UBI and the "freedom to fail" that a UBI could provide.

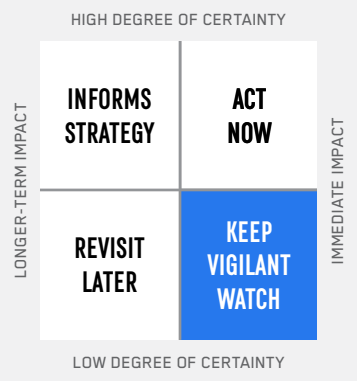
Watchlist

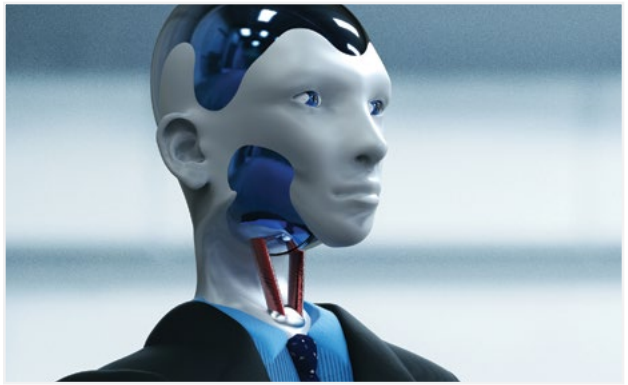
Finland; Scotland; Y-Combinator; The Roosevelt Institute; Facebook; Mark Zuckerburg; Elon Musk; The Royal Society for the Encouragement of the Arts, Manufacturers and Commerce; Stanford Center for Philanthropy and Civil Society; American Enterprise Institute.

SECOND YEAR ON THE LIST

AI in Hiring

201





AI systems are being used to help in the hiring process.

Key Insight

Artificial intelligence and machine learning tools are being used in the hiring process with the hopes of identifying more qualified candidates, eliminating human bias, and reducing time spent on automatable tasks.

Examples

There are numerous ways that companies and recruiters (both large and small) are using artificial intelligence throughout the hiring process. Resume reviewers can quickly analyze resumes for designated keywords, years of experience, and grammatical errors, while also attempting to remove potential bias from factors such as gender, race, or nationality. Companies can automate the pre-interview process by mapping a person's internet presence and also via assessments with tailored questions to evaluate a potential candidate's responses. This screening can also help larger companies find qualified candidates who might not have applied for the original job posting. AI is also being used within the interview process to analyze responses to particular questions.

What's Next

As our economies grow, so will the need to fill new jobs. LinkedIn alone averaged 20 million views a week with over 14 million of those submitting job applications. There are numerous companies and startups in the space that will attempt to offer suites of products to companies and recruiters. Larger companies will consider AI to help optimize and streamline unruly amounts of applicant information and to attempt to make better hiring decisions. Smaller companies with more limited resources will rely on AI to conduct hiring tasks that take humans longer to complete. Recruiters might begin to rely on AI more to differentiate their candidates versus the competition.

But AI in hiring does not come without risks. The first: AI solutions are only as good as their initial programming and the datasets being used. Secondly, if the hiring process relies more on automation, the potential arises for applicants to game their resumes and responses based on what they think the AI systems will preference.

Watchlist

LinkedIn; Interviewed; Facebook; Amazon; Talent Sonar; HireVue; FAMA; SkillSurvey; Avrio; Alphabet.

NEAR-FUTURE SCENARIO FOR AI IN THE HIRING PROCESS

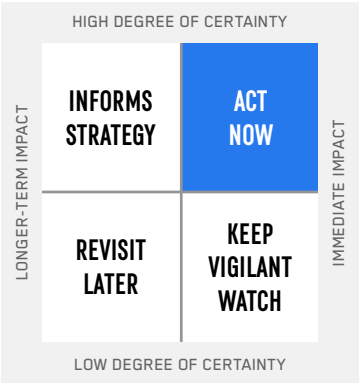
Roy Levkovitz

The most probable future is that AI is used in varying degrees by companies to improve hiring decisions while freeing up resources of HR teams to do more "human" tasks. But it would not be surprising to hear that some companies have shrunk their HR staffs or employed a completely automated hiring process free from human interaction in the very near future.

THIRD YEAR ON THE LIST

Productivity Bots

202



Slack is a popular platform enabling productivity bots at work.

Key Insight

Productivity bots aim to help teams and individuals operate more productively by automating tasks that are time consuming and often mundane for individuals–but perfectly suited for bots.

Examples

With over 6 million daily users, **Slack** is by far the most popular platform integrating hundreds of productivity bots with the workplace. The **Obie bot** is used as an onboarding tool, allowing new employees to find answers to simple questions about the company. Scheduling bots like **Meekan** sync up with coworkers' calendars to provide possible meeting times. If you're trying to reduce wasted time that a stand-up meeting takes up, bots send out a request for an update from team members and pushes out a report once everyone has sent theirs in. Bots like **Lunch Train** help coordinate team lunches and their locations. Slack isn't the only platform being used: **MatterMost** and **Rocket.Chat** allow companies to host all content locally, rather than in the cloud.

What's Next

Automation and productivity tools like Slack will likely continue to move toward the mainstream during 2018– cannibalizing traditional office technology, like email.

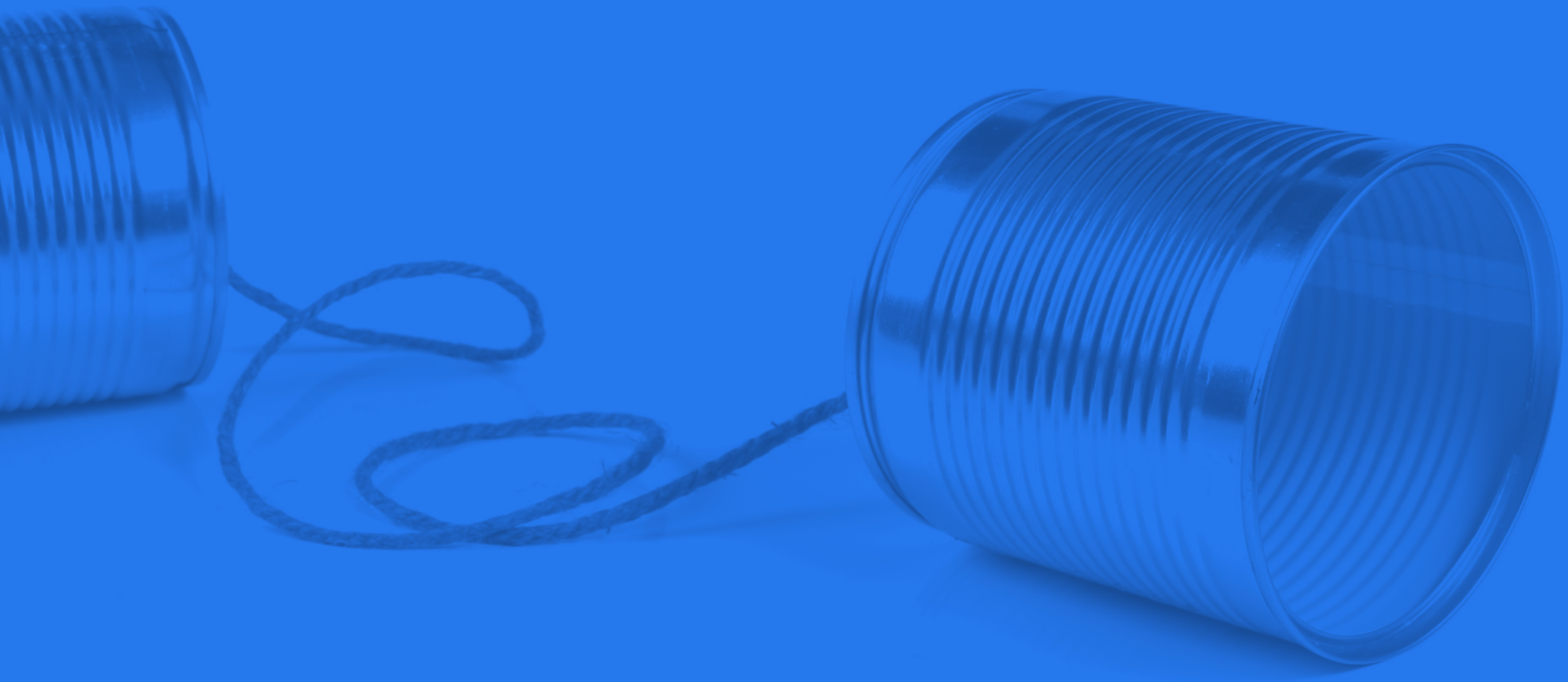
Watchlist

Slack; Rocket.Chat; MatterMost; X.ai; Workbot; Obie; Microsoft; Howdy; Standup Alice; Geekbot; Meekan; Skype.

A NEAR-FUTURE SCENARIO FOR EMAIL-FREE COMPANIES

Roy Levkovitz

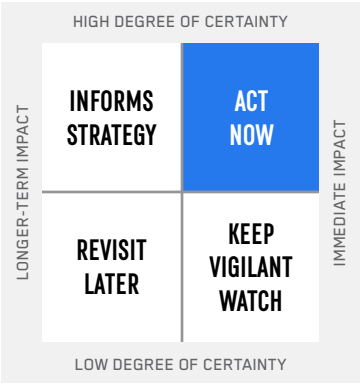
With teams constantly needing to be connected, e-mail will be viewed as a slower and less efficient form of communication. Because of this, companies will move away from email entirely. But for companies that must keep a paper trail, what would the legal considerations be once employees are chatting and using bots? It's possible to create logs, but they would be difficult to sift and sort through. For those companies that monitor staff email for regulatory reasons, messaging systems like Slack could make compliance difficult.

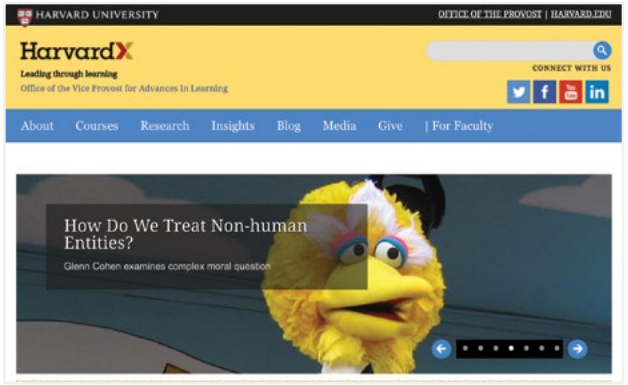


SECOND YEAR ON THE LIST

Adaptive Learning

203





Harvard is testing adaptive learning software.

Key Insight

An interactive teaching method powered by artificial intelligence that can be used by businesses and educational institutions to tailor curriculum for individuals based on correct and incorrect responses to questions.

Examples

In a 2017 course on the open course platform **HarvardX**, students who were placed into the adaptive learning track outperformed the control group by 19%–in fact, they outperformed their peers across different key learning objectives. In a business setting, adaptive learning systems are being used by employers to onboard new staff, train employees, help hone specific skills and understand an individual's specific strength and weakness. These systems adapt to the individual learning patterns and cognitive skills of students. Content and exams are customized in real-time, as the system autonomously determines where a student needs additional focus. Current systems let instructors know where more personalized attention is needed.

What's Next

K-12 schools alone have spent over $41 million on adaptive learning technology, or three times the amount that was spent in 2013.[4] Despite this increase in funding, widespread adoption of adaptive learning in schools will still likely lag behind the corporate setting due to the relative lack of resources and infrastructure.

We expect to see adaptive learning technologies more deeply integrated into staff training and talent development during 2018.

Watchlist

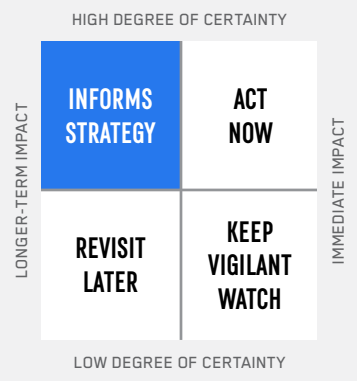
NovoEd; Everwise; HarvardX; Pearson; Dreambox; IBM; Microsoft; Knewton; Axonify; Qstream; Intrepid; Geekie.

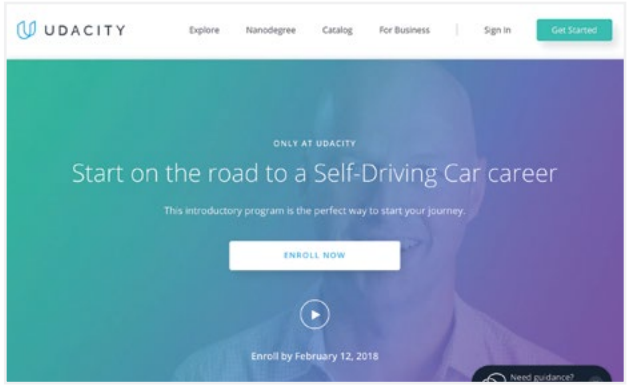
[4] *EdTech Magazine, "School Districts Have Tripled Spending on Adaptive Learning Technology." Last accessed January 19, 2019.*

THIRD YEAR ON THE LIST

Nanodegrees

204





Udacity offers nanodegrees and enrolls thousands of students worldwide.

Key Insight

The study of a specific topic area or industry normally done through an online institution, with the goal of increased knowledge in the area and some form of certification of completion.

Examples

Nanodegrees are being pursued by individuals as an alternative to a traditional 2 or 4-year degree, more expensive and time consuming masters programs, or simply as an approach to receive a certified understanding of a topic. **Udacity**, one of the most popular platforms to earn nanodegrees, currently enrolls more than 50,000 students in various programs that take approximately 6-12 months to complete. These programs tend to be more cost-effective, too: they're billed per-term or on a month-to-month basis. Nanodegrees tend to be clustered around technology: data science, skills for developers, and digital marketing.

What's Next

One of the biggest hurdles for people pursuing nanodegrees is a relative lack of awareness or understanding of the programs amongst HR and hiring staff. But that's changing fast. Large corporations, including **AT&T**, **Google**, and **Disney**, have launched nanodegree programs to provide employees with additional training and career advancement skills. As more corporate training programs follow suit, the value of nanodegrees will also rise. We could also see the development of alternative learning programs, such as **Seth Godin's altMBA**, to proliferate to other areas of study as early test cases move from the fringe to the mainstream.

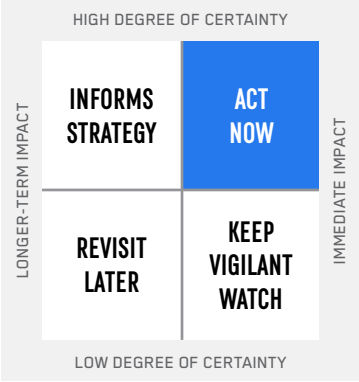
Watchlist

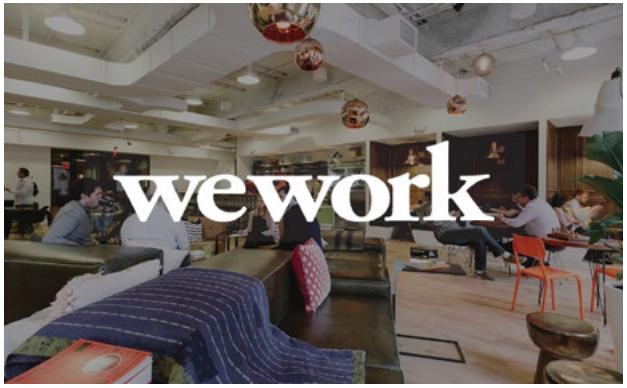
Udacity, Google, Amazon, Coursea, altMBA, Stanford, Harvard, AT&T.

FOURTH YEAR ON THE LIST

Sharing Economy & Lendership

205





WeWork is a collaborative workspace housing sharing economy startups.

Key Insight

People are increasingly comfortable renting goods and services versus needing to own them. Across various industries, service providers or communities have begun to pool resources for a fee.

Examples

Uber, **Rent The Runway** and **Airbnb** are just three of the thousands of sharing economy companies used by 56 million Americans in 2017. Sharing economy companies are everywhere: transportation, real estate, retail, professional services, even biotechnology. The sharing economy is becoming meta: **WeWork** is a collaborative workspace that houses many sharing economy startups. It earned a $20 billion valuation in late 2017.

What's Next

The sharing economy is expected to continue growing in the coming years, but this growth will likely occur in different ways. In countries like the **U.S.**, where a large percentage of the population already has access to the internet and smartphones, the sharing economy market is already fairly mature and robust. Further growth will come in the form of more unique B2B, B2C and C2C services. Companies will optimize resources by renting out unused equipment to each other and sharing workspaces. Likewise, we expect to see a new crop of companies that exist to provide shared services for upcoming niche industries (baby stroller rentals for traveling families). The success of these newer companies will depend on how consumers value their services–and importantly, whether local, state, or federal entities see the need for regulation.

But a digital divide still exists. Developing markets still need better, cheaper access to the internet–and they need smart phones. As more citizens gain access to smart phones, we anticipate a spike in sharing economy growth. It's already starting to happen across **Latin** and **South America**, with local companies like **Komlep** helping to build the infrastructure for sharing and lendership.

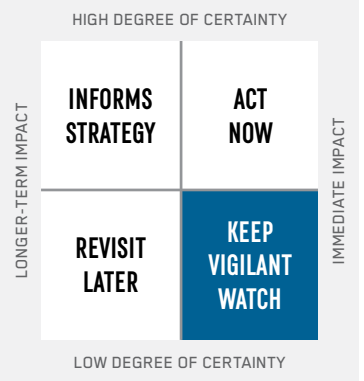
Watchlist

Crowd Companies Council; Facebook; Etsy; Luxe; Peerspace; Zaaryl; LawnLove; Rent The Runway; Airbnb; Komlep; WeWork; Style Lend; PoshMark; Funding Circle; Sparkbox; FarmLink; Toys Trunk; Uber; Lyft; Postmates; Saucy; NeighborGoods; Vayable; ToolLocker; Trustify; Seateroo; Scribendi and many others.

FINANCIAL TECHNOLOGIES AND CRYPTOCURRENCIES

SECOND YEAR ON THE LIST

E-Resident and Location-Independent Digital Business Identity Cards



206

Key Insight

E-residency is now being offered in **Estonia**, making it easier for entrepreneurs to establish location independent businesses with access to EU financial infrastructure. Other countries are looking at similar models to attract startups and funding.

Examples

Estonia, which borders **Russia** to the east, Latvia to the south and sits across the **Baltic Sea** from **Finland**, has been operating most of its government services online for the past 15 years, from tax filing to contract signing to filling prescriptions and even voting. With a population of just 1.3 million people, Estonia figured out early on how to operationalize digital tools to service its citizens.

Recently, Estonia began offering digital identities with a financial status of resident to entrepreneurs–without requiring that they physically take up residence in the country. As part of this beta program, e-residents pay 100 euro and apply online at e-resident.gov.ee, and then need to travel to a local Estonian embassy for an interview and to receive a smart card, which they can use to sign documents online. Once approved, e-residents gain access to a number of services–including an **E.U. company designation** and **E.U. bank accounts**. This generates revenue for the Estonian government while reducing costs and paperwork for entrepreneurs around the world.

Estonia's e-residents are primarily composed of six groups:

1. Digital nomads who seek location independent incorporation
2. Entrepreneurs/freelancers seeking E.U. market access and its benefits, including its legal frameworks, access to financial services, and higher level of trust
3. Entrepreneurs within the E.U. whom seek to reduce costs vs. their physical residency
4. Entrepreneurs facing Brexit who are seeking to retain access to E.U. markets
5. Startup entrepreneurs seeking funding from new regions
6. Blockchain entrepreneurs leveraging trusted digital identification

Estonia offers e-residencies for foreign entrepreneurs.

What's Next

We expect that the popularity of Estonia's e-residency program to increase, as more global entrepreneurs seek to gain access to E.U. consumers and financial infrastructure. With the Brexit referendum passed, e-residency could provide a smart solution for U.K.-based entrepreneurs, who will soon find it difficult to work with E.U. companies and to hire E.U. citizens. Planned open banking regulation in Europe–like PSD2 (Payment Services Directive, expected in market 2019)–will create banking interoperability and portability standards that will make it easier to take advantage of location independent programs. It should also make it easier for companies to incorporate geographically where they receive the most benefits for the lowest cost. We also believe that digital identities will increase in popularity as more businesses seek to cut costs and paperwork by using digital signatures verified by trusted third parties.

Watchlist

Estonia's e-residency program; financial services providers supporting e-residency; Holvi; LHV; Swedbank.

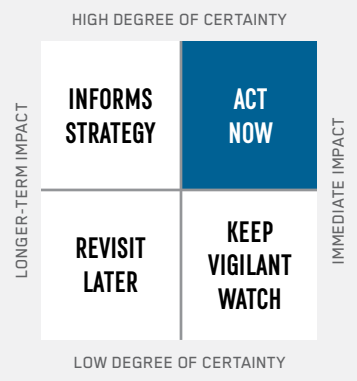
SCENARIO

Kriffy Perez

In the more distant future, there will be bifurcation between countries and regions that try to prevent capital and taxes from leaving their borders. The U.S.'s foreign earned income taxation program could put it at a big disadvantage. Estonia's e-residency program promotes the stimulus of incoming capital–while Spain has a lower income tax for new foreigners ("The Beckham Law"). It's plausible that America's next centers of talent and innovation could relocate to Europe.

EIGHTH YEAR ON THE LIST

Social Payments



WeChat Pay is quickly becoming a preferred method of payment in China.

207

Key Insight

Financial service and payment providers are tapping into social interactions as a driver of preference for financial services.

Examples

Initially, systems like **Apple Pay**, **Google Pay**, and **Samsung Pay** were designed primarily for online purchases, followed by convergence into in-store transactions. Those programs are now expanding, allowing person-to-person (P2P) payments and seamless integration into other apps and services. Last year, many established technology players–including **Facebook**, **Snap**, Google and Apple--launched functionality to enable P2P payments.

The most advanced players seek to embed the functionality as seamlessly as possible into existing customer experiences, including chat applications. The **iMessage** platform allows P2P payments, via chat, across many different platforms, including **Venmo** and **Square Cash**. The majority of these services do not charge transaction fees. **Wechat** and **Alipay** are significant players in the **Chinese** mobile payments space due to their highly developed network of merchants that accept chat-based payments, blurring the lines between sending money to a friend vs. sending money to a store.

What's Next

We believe that the payments infrastructure will become an invisible service layer that goes behind quality customer experiences. The market should evolve on three fronts:

1. **User experience integration:** Splitwise integrates Venmo, where Splitwise calculates the net balance owed or due across roommates and Venmo executes the payments.

2. **Increasing acceptance/size of the network:** PayPal enables merchants to receive Venmo transactions. This is an example of letting customer interactions drive payment preferences at digital merchants, effectively expanding the size and value of the Venmo network overnight.

3. **Traditional financial service players entering/purchasing the space:** Banks are partnering or buying infrastructure to enable P2P payments. For example, Citibank has partnered with Zelle to allow for payments-to-contacts email addresses. Mastercard and Visa are allowing card-to-card payments through services such as Mastercard Send or Visa Direct.

Focusing on customer experience is key. This should lead to a period of expansion, where multiple fragmented platforms and services will be accepted for specific use cases. Partnerships will eventually begin to coalesce, driven by primary relationship holders, price and strength of the network–for example, Android Pay and Google Wallet merging into Google Pay. It is additionally worth noting that as social payment networks increase in popularity and scale, they will become more vulnerable to hackers and fraud.

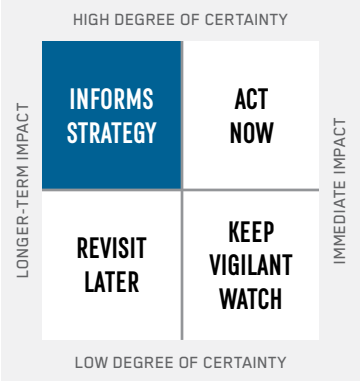
Watchlist

Apple; Google; Amazon; Microsoft; Facebook; PayPal; WeChat; Alibaba; Mastercard; Visa; Ingenico; Citibank; BBVA; Zelle; Exeq.

FIFTH YEAR ON THE LIST

Cryptocurrencies

208



Key Insight

Cryptocurrencies are digital assets or stores of wealth that use a crowd-regulated public ledger system. Bitcoin is the most common example of a cryptocurrency, or digital currency. Cryptocurrencies provide a financial vehicle that is free of single ownership/operation, and they ensure trust because all transactions are made in public.

Examples

Cryptocurrencies have exploded in popularity, notoriety, value and volatility in the past year. There is significant variation in features, benefits and structures across cryptocurrencies with some focusing on global transactions, faster transactions, transactional utility, anonymity, privacy, and computational functionality.

Bitcoin remains the most recognized, with the largest market capitalization followed by **Ethereum** and **Ripple**. Bitcoin was designed with the intention of providing "a peer-to-peer electronic cash system." It was intended as a worldwide, decentralized digital currency, where P2P transactions are recorded in a pseudo-anonymous public distributed ledger.

2017 has been a turbulent year for Bitcoin. It crashed 30% six times, yet was up more than 1,500 % over 12 months. **J.P. Morgan Chase Chairman and CEO Jamie Dimon** called bitcoin a fraud–then backpedaled, suggesting that each cryptocurrency be looked at individually. Like others, he supports the **blockchain** technology underlying Bitcoin. While the initial intent of Bitcoin was to function as a digital currency, Bitcoin is displaying behavior suggestive of a **new speculative asset class** (such as Gold or Diamonds), which is not valued based on its functional value.

What's Next

In general, we expect to continue to see significant new cryptocurrency entrants, as well as fresh opportunity and continued high volatility as regulation and markets adjust to find equilibrium. We believe that traditional cryptocurrencies will bifurcate into two primary uses that will dictate their future path of evolution:

New asset class: The direction of this evolution is evidenced by the increasing popularity of **Initial Coin Offerings (ICOs)** as a means of funding companies without the current regulatory rigors and requirements of the current securities market. ICOs provide global access to funds while having no standards of ownership, participation, reporting or investor protection requirements of established securities markets. We expect to see a significant increase in the entrants with this objective in mind and also expect to see increased regulatory action aimed at bringing ICOs, exchanges and trading into alignment with existing financial structures.

Digital currency: We see this use case decreasing in importance, popularity and relevance. Cryptocurrencies face a significant hurdle in acceptance and volatility if they are to become true currencies. Consumers would need to be able to reliably exchange currency for a good or service, and at the moment, it's difficult to do that with Bitcoin. We do not see acceptance of cryptocurrencies growing as a means for exchange at a wide-scale level. When we look at Bitcoin, its volatility makes it too risky to accept and hold payments. Just imagine if your accounts receivable decreased by 23% in just one day, as it would have when the market dipped December 21-22, 2017.

Watchlist

Bitcoin; Ripple; Ethereum; Litecoin; Dash; Monero; Cardano; Coinbase; Estcoin; Coindesk; Counterparty; Openledger; SEC; FED; Central Banks; e-Dinar, eCFA.

FUTURE SCENARIOS: PROMISES AND CONCERNS

Kriffy Perez

NEAR-FUTURE SCENARIOS FOR THE FUTURE OF CRYPTOCURRENCIES

As global fiscal policy begins to stabilize and unify in the next 5-10 years, countries will need to develop fundamental perspectives and an approach to integrating cryptocurrencies into their existing financial structures. Here are a few plausible scenarios describing how things might turn out:

OPTIMISTIC FRAMING

Cryptocurrencies are fully accepted as a new asset class for investment (exchanges), fund raising (Initial Coin Offerings), as an unrestricted currency (cross-border transactions) and as a means of income (mining). This would lead to governments issuing national cryptocurrencies that are interchangeable with analog currencies, and are freely traded on public exchanges and accepted by a majority of merchants.

Likelihood of this scenario happening: 20%.
This scenario would be most attractive to small and emerging economies, who have a greater appetite for risk, and who could capture capital from other global markets and have lower legacy barriers to development and change.

PRAGMATIC FRAMING

Cryptocurrencies have limited acceptance. Countries establish rules and regulations around specific elements and uses of cryptocurrencies, generally with the intention of limiting the impact on the sovereign currency and country macroeconomics. Governments create cryptocurrencies that function independently of traditional currencies where acceptance is restricted to specific use cases—similar to when import taxes must be paid for with government-issued postage stamps.

Likelihood of this scenario happening: 50%.
Most developed and large economies will seek to take a risk-averse approach to evolving their economies. They will test out smaller changes limiting their impact on macroeconomics, as there will be an opportunity to capture greater tax revenues, reduce costs and provide services that citizens are demanding.

CATASTROPHIC FRAMING

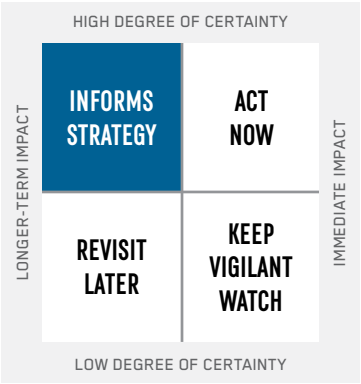
Cryptocurrencies face extreme regulation or they become banned outright. Governments impose such harsh restrictions on cryptocurrencies that they are less beneficial and useful than existing financial products. Cryptocurrencies are relegated to black market uses. They are the backbone of the grey economy, where transactions are made to avoid government watchdogs.

Likelihood of this scenario happening: 30%.
Countries will try to limit and ban cryptocurrencies, but they will lack the resources and enforcement to stop their use.

FIRST YEAR ON THE LIST

Blockchain

209



The blockchain is a distributed public ledger of transactions.

Key Insight

The blockchain is a distributed public ledger of transactions that is continuously growing. Cryptography is used so that after a transaction is recorded, it is visible to all and cannot be changed without changing the entire ledger. Blockchain reduces the need for intermediaries as the ledger is available to all.

Examples

Variations of blockchain technology are most frequently being utilized to create record books that cannot be changed and are available for all parties to see. Records of diamond sourcing and provenance are being written into blockchains like **Everledger.io** as a way of providing digital records that ensure authenticity, ethical sourcing, and quality.

Blockchain technology also allows for the coding of specific commands into the records. This leads to smart contracts, where the code is embedded in the transaction that keeps track of terms of agreements and performs actions at specific moments without interaction from human intermediaries. (For example, paying royalty fees to musician whenever a song is played.)

What's Next

Industries that rely heavily on record keeping, ownership and trust are going to be most impacted by the development of solutions that leverage **blockchain technology**. Industries such as **financial services**, **insurance**, **healthcare**, **supply chain**, and **government services** are primary targets for blockchain innovation. Many current solutions use consensus verification methodology, and that consumes significant computer resources and electricity. Current verification, storage and cryptographic methods will need to evolve for blockchain solutions to achieve the size, scale, and efficiency that is necessary to replace existing systems.

Going forward, the process in which companies set up their systems and infrastructure is likely to change with the rise in popularity of blockchain technology. Industries and businesses have begun to think more about decentralization, who ensures trust, and efficiencies from distributing responsibilities across a broader ecosystem of players. We expect blockchain to remain popular in the form of pilots and small-scale implementations as many large institutions and startups begin to explore how to develop the technology and how to apply the ideology to various use cases across multiple industries.

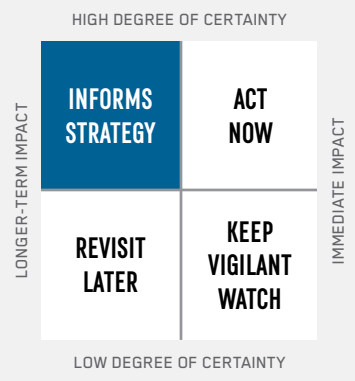
Watchlist

CITI; ING; HSBC; Bank of America; UBS; JPMorgan Chase; Ethereum; IBM; Hyperledger; Steemit; Counterparty; Quorum; Bitnation; Solidity; International Monetary Fund.

FIRST YEAR ON THE LIST

Open Banking

210



New technologies could make it easier for banks to conduct business.

Key Insight

Financial data is becoming standardized and interoperable, facilitating access to banking infrastructure and analytics for third parties.

Examples

Mint.com and other financial aggregators use **API** access to financial data or screen scraping to build their own databases of their customers' financial transactions. Using this information, **fintech providers** can give consumers a holistic view of their finances across multiple banks and types of assets. The rich financial data generated is often used for marketing purposes by suggesting products that may meet the needs of the consumer more than their existing products.

By 2018, the **European** regulation known as **Payment Service Directive Two** (PSD2) will require banks to enable third parties to access a customer's financial data. PSD2 lays the foundation for new players to use financial transaction data to improve analytics behind product development, predictive analytics, fraud analysis, marketing and a la carte services being offered by an ecosystem of providers.

What's Next

Regulation will change the ownership structures of financial data. Interoperability will make it easier for customers to aggregate finances and choose a la carte services from various providers that best suit their needs. There will be increased activity of fintech's and partnerships among incumbent players as incumbents seek to stay current and drive customer preference through services offered. We expect disruptive fintech innovators to build functionality that attracts a critical mass of consumers, which will then trigger large incumbents to seek partnerships. Incumbents that are slowest to enable data access to third parties will see attrition from their customer base as consumers move to providers that give them access to the new ecosystems.

The most successful players will be those who can get access to the richest data and are most effective at productizing data driven insights, likely through personalized marketing and operating efficiencies like reducing fraud and chargeback rates.

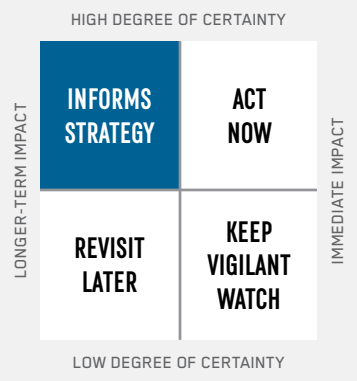
Watchlist

Mastercard; Visa; American Express; CITI; BBVA; Banco Santander; HSBC; Wells Fargo; Lloyds; Intuit; Square; iZettle; N26; Fidor; Klarna; Monzo; Plum; Bean; Exeq; Clear.

FIRST YEAR ON THE LIST

Financial Inclusion and Targeting the Underbanked

211



In 2014 an estimated 2 billion adults did not have a bank account.

Key Insight

Financial players are targeting the segments of the population that are unbanked or underbanked (have limited or do not have access to financial products.)

Examples:

Walmart offers banking services provided at its **Money Centers**, which include credit cards, prepaid debit cards, money transfers, bill payments, check cashing, tax preparation services and checking/debit alternatives. The checking account alternative **Bluebird** is provided by **American Express** and provides many of the benefits of a traditional bank account with reduced fees. Credit building products that are designed specifically for people with limited or bad credit have become more popular and available. For example, **Captial One Secured Mastercard** is specifically designed to build credit history and incentivizes responsible card use.

What's Next

As financial services become more dependent on scale and risk management to be competitive, more products will be designed and targeted at people on the fringe of the banking system. Financial service providers are beginning to see the opportunity of growing their addressable population, instead of only focusing on competing for the same people. Large players who have already invested in the infrastructure and systems to deliver financial services will see low marginal costs in addressing new customer segments. Smaller startups will be willing to take on greater risks on low credit worthy customers through new risk management practices based on rich new data streams, thereby making new customer segments profitable for service providers. Financial education will also prove important, as many of these new customers will be at risk of exploitation, short-term financial planning and predatory debt practices. Governments will continue to increase the benefits and salaries distributed in digital formats that will increase participation in the banking system.

Watchlist

Carrefour; Walmart; Falabella; World Bank; IMF; FICO; Citi; Wells Fargo; USAA; KeyBank; TDBank; JPMorgan Chase; Capital One; Mastercard; Visa; American Express; mPesa; GoBank.

"Financial inclusion is no longer a fringe subject. It is now recognized as an important part of the mainstream thinking on economic development based on country leadership."

– Alliance for Financial Inclusion (AFI) Executive Director Alfred Hannig , IMF-World Bank 2013 Spring Meetings.

SMART CITIES

What makes a city "smart?"

In 2016, 78 cities applied for the U.S. Department of Transportation's "Smart City" challenge, which would award the winner $40 million in federal grant money to upgrade their urban transit systems. DoT selected Columbus, Ohio, as the winner for its proposal to deploy self-driving electric shuttles, launch smart cards to provide free car-sharing services, and develop a connected traffic light system to reduce traffic jams throughout the city. The City of Melbourne (Australia) has launched a Smart City Office, which includes open data projects, a 24-hour pedestrian counting system and city-wide free public WiFi.

Public-private partnerships, affordable technology, long-term urban and budget planning, and equal access to all citizens are just a few things that make cities smart.

Here's a more complete list:

- *government data that's digitized and accessible*
- *citizen data that's anonymized, digitized and accessible*
- *community leaders who are experts in tech*
- *proactive cybersecurity staff dedicated to continuous learning*
- *abundant 4G (and soon 5G) connectivity*
- *smart grids for traffic and electricity*
- *public transit systems optimized for riders*
- *availability of car and bike-sharing services*
- *public-private tech partnerships that benefit all income levels*
- *environmental protections*
- *clean energy options*
- *long-term urban planning*

Sources: United Nations, European Commission, Pew Research Center, EasyPark Group.

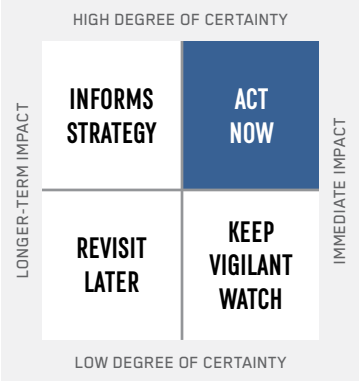
These are the world's smartest cities in 2018.

01. Abu Dhabi
02. Amsterdam
03. Berlin
04. Boston
05. Copenhagen
06. Doha
07. Dubai
08. Geneva
09. Gothenburg
10. Hamburg
11. Helsinki
12. Hong Kong
13. London
14. Luxembourg
15. Melbourne
16. Montreal
17. New York
18. Osaka
19. Paris
20. San Francisco
21. Seoul
22. Singapore
23. Stockholm
24. Tallinn
25. Tel Aviv
26. Tokyo
27. Toronto
28. Vancouver
29. Zurich

FIRST YEAR ON THE LIST

Smart City Initiatives

212



San Francisco is one of the smart cities deploying sensors and collecting data.

Key Insight

As the Internet of Things ecosystem matures, there will be new opportunities for city managers to manage infrastructure, traffic and daily living.

Examples

The market for smart city projects could increase to more than $1 trillion by 2025. In the **U.S., Senator Maria Cantwell** and **Representatives Suzan DelBene** and **Ben Ray Luján** introduced the **Smart Cities and Communities** Act, which would make funding and technology accessible to local governments for smart city initiatives. In cities throughout the U.S., universities are starting to partner with city councils on a wide range of experiments. Seattle, the Argonne National Laboratory and the University of Washington are deploying a variety of sensors around the city to improve hyper-local weather forecasting due to climate change.

What's Next

There is a significant talent shortage–those who have the right skills set and experience tend to take much higher-paying jobs in the private sector. As a result, cities will need to carve out enough budget to pay for staff. And they'll need to do it quickly: cybercrime won't wait for local city and town budgets to pass.

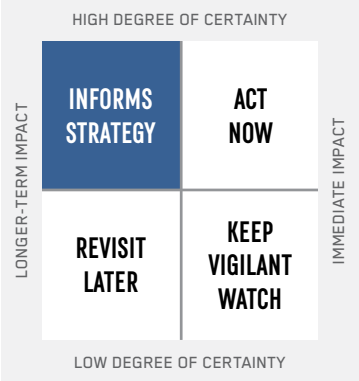
Watchlist

Local city and town agencies; local business leaders; local universities and colleges; Congress; European Union.

THIRD YEAR ON THE LIST

Faster Connectivity With 5G

213



5G Evolution℠

5G trials are already underway worldwide.

Key Insight

5G trials, supported by the **Federal Communications Commission** and the **European Union,** are underway around the world.

Examples

5G is the fifth generation of wireless technology. We had 1G in the early 1990s and 2G in the late 90s, which enabled us to send text messages between two mobile devices. 3G supported our ability to browse the internet. Now, with 4G, we're able to download and upload large videos. 5G will dramatically increase the speeds at which we connect–we'll be able to pull **HD** and **3D video** and use **VR** in the cloud, since download speeds will hover around 10 gigabits per second, which will be a boon for news organizations that distribute video content. But it isn't just our phones that will use the connection: **driverless cars**, **smart cities**, and **smart grids** will all rely on 5G.

What's Next

Local internet service providers have been reluctant to upgrade their networks, but that's starting to change. Already, some carriers are integrating **Gigabit LTE** into their existing networks, a sort of pre-5G upgrade. In the U.S., **AT&T** and **Verizon** have both announced limited-scale 5G rollouts during 2018, though it's more likely the networks will be ready in 2019. However, once the networks are ready, the changeover to 5G-enabled devices will be swift.

Hardware manufacturers like **Qualcomm** are readying 5G modems and advanced chipsets. Globally, there will be a new wave of spectrum auctions (and arguments).

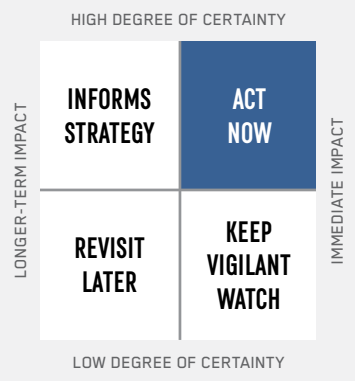
Watchlist

Federal Communications Commission; European Union; Qualcomm; Intel; ISPs.

SECOND YEAR ON THE LIST

City-Level Cyber Security

214



More cities should hire trained cybersecurity staff in 2018.

Key Insight

With more local government services moving online, cities and towns will need to hire qualified cybersecurity managers.

Examples

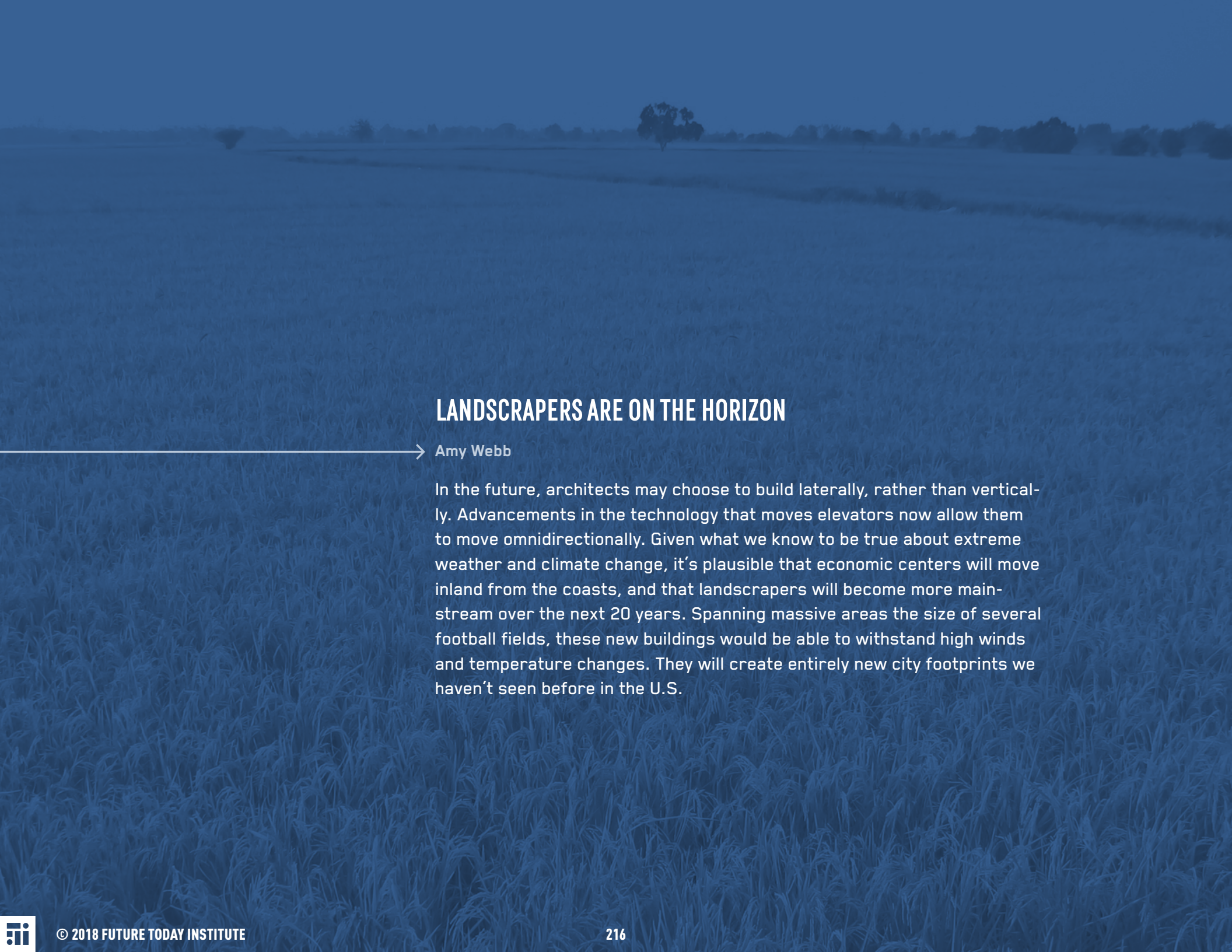
Cities with high-profile residents like **Minneapolis** (home to many Fortune 500 companies, including **Best Buy** and **Target**), **New York City** (home to celebrities and financiers), and **Arlington** (the **Pentagon**) have been actively seeing cybersecurity experts to fill new positions.

What's Next

There is a significant talent shortage–those who have the right skills set and experience tend to take much higher-paying jobs in the private sector. As a result, cities will need to carve out enough budget to pay for staff. And they'll need to do it quickly: cybercrime won't wait for local city and town budgets to pass.

Watchlist

Local city and town agencies; local business leaders; local universities and colleges.



LANDSCRAPERS ARE ON THE HORIZON

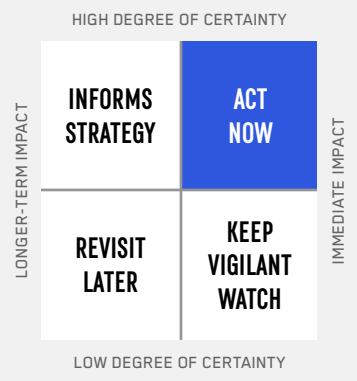
Amy Webb

In the future, architects may choose to build laterally, rather than vertically. Advancements in the technology that moves elevators now allow them to move omnidirectionally. Given what we know to be true about extreme weather and climate change, it's plausible that economic centers will move inland from the coasts, and that landscrapers will become more mainstream over the next 20 years. Spanning massive areas the size of several football fields, these new buildings would be able to withstand high winds and temperature changes. They will create entirely new city footprints we haven't seen before in the U.S.

GOVERNMENT AND TECHNOLOGY POLICY

SECOND YEAR ON THE LIST

Splinternets



Europe's "right to be forgotten" laws could mean widespread splinternets if they aren't accepted as a global standard.

215

Key Insight

Twenty years ago, the internet emerged as a global space where information wanted to be free. Now, everyone has a different idea of how our global information superhighway ought to be regulated, and by whom. As a result, we are headed towards a fragmented "splinternet" in the future.

Examples

Search is controlled by a small number of American companies–there is no **United Nations** or other international organization with any power to establish standards, norms and regulations that is recognized by everyone using the internet. In the past decade, countries in Europe fought ISPs and search providers such as **Google** and **Yahoo** in court and successfully banned content on a country by country basis. In the summer of 2017, **Germany** passed a law forcing social media companies to delete hate speech within 24 hours of posting, or pay fines of up to $57 million. **Canada's Supreme Court** ordered Google to remove pirated content from search results. **French lawmakers** are working to make **Europe's** "right to be forgotten" laws applicable worldwide. The result of this regulation has meant that the internet looks and behaves differently depending on geography. Citizens in countries where free speech isn't valued could find their version of the internet without a digital outlet for watchdog journalism.

What's Next

The companies involved have maintained that they're "just technology companies," however their strictly-defined roles as arbiters of information will be tested in courts in the coming years.

Without coordinated effort, splinternets will continue to proliferate in the years ahead. This could make disseminating quality journalism more difficult in regions around the world. But it could also cause tremendous headaches for news organizations who distribute–and monetize–content for a global audience.

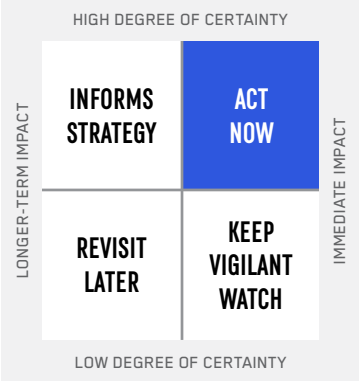
Watchlist

European Union; Google; Facebook; Baidu; Twitter; Amazon; Microsoft; Netflix; Apple; Federal Communications Commission.

FIRST YEAR ON THE LIST

Election Security

216



It's now clear that **Russia** meddled in the 2016 U.S. election.

Key Insight

In 2018, a growing number of bipartisan and national security leaders will call for election security changes ahead of the midterm elections this fall.

Examples

It's now clear that **Russia** meddled in the 2016 U.S. election. This included pilfering local election databases, meddling with elections databases, and hampering the registration operation in districts around the country, and deliberately spreading false or misleading information during the campaign cycle. We made it easy for hackers to break in. During the 2016 election, 43 states used electric voting machines that were perilously out of date.

What's Next

This year, a number of government agencies will speed up their usual processes to deal with a backlog of election-related vulnerability assessments. But it will take significantly more funding, better technology, sweeping changes to polling station training programs, and scores of security experts to shore up our nation's elections infrastructure before the midterm election. Threats to the integrity of our elections could elevate this to a national security issue, and could signal a federal takeover of state and local elections.

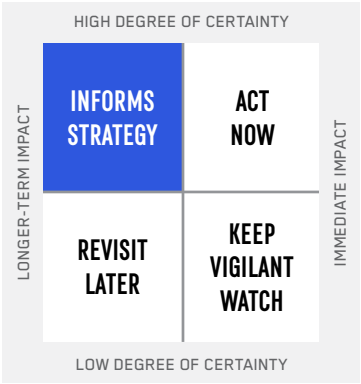
Watchlist

Caltech/MIT Voting Technology Project; Presidential Commission on Election Administration; National Conference of State Legislatures; Department of Homeland Security; National Security Agency; Central Intelligence Agency; Russia.

FIRST YEAR ON THE LIST

Anti-Trust Lawsuits

217



Amazon has an enormous retail footprint, but so far none of its ventures amount to unfair competition.

Key Insight

Antitrust laws exist around the world. They exist to ensure and promote fair competition between companies for the benefit of consumers. As media and technology companies consolidate in 2018, there will likely be a number of new antitrust suits brought in an effort to thwart monopolies.

Examples

Last year, the **E.U.** fined **Google** a record-breaking $2.7 billion for what adjudicators said was illegally nudging users to its comparison shopping site rather than to the online retailers themselves. The **U.S. Justice Department**, under **President Trump**, sued to block **AT&T's** $85.4 billion bid to buy **Time Warner Inc.**

What's Next

In January 2018, **Apple** announced plans to move vast troves of cash from overseas banks back to the U.S.–it could have a stockpile in excess of $100 billion cash, even after paying the government $38 billion in taxes. A chunk of that money will be used to acquire startups and technology. Both **Alphabet** and **Amazon** have been making acquisitions of their own.

But our existing antitrust laws don't always mesh with our ever-evolving business landscape. For example, **Amazon** recently acquired **Zappos**, **Diapers.com** and **Whole Foods**. Together, all three give the company a much larger retail footprint, but individually, each acquisition doesn't amount to unfair competition. (It's not the same as **Walmart** buying **Publix** and **Safeway**.) However, as Amazon continues to build digital payments, logistics and package delivery infrastructure, it could indirectly crush other retailers who don't also use its platform. But that still wouldn't be illegal. At the moment, we don't have any laws against being really, really smart.

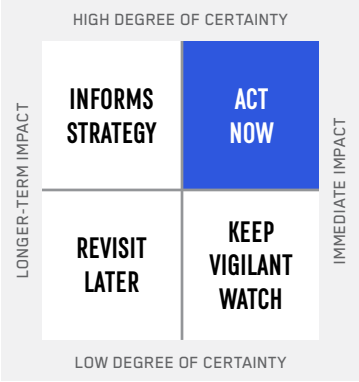
Watchlist

Department of Justice; Federal Trade Commission; E.U.; Apple; Amazon; Alphabet; internet service providers; technology companies.

THIRD YEAR ON THE LIST

Old Laws Clash With New Technology

218



In *WarGames*, Matthew Broderick played a hacker who brought the U.S. and former Soviet Union to the brink of nuclear war.

Key Insight

Technology is now moving faster than any government's ability to legislate it. As a result, countries around the world are learning the hard way what happens when old laws clash with new technology.

Examples

In the **U.S.**, the **Computer Fraud and Abuse Act (CFAA)** was enacted shortly after lawmakers showed a clip of the 1984 movie *WarGames* during testimony–it was an iconic scene about the brink of nuclear war with Matthew Broderick, as a teenage hacker. The CFAA's broad language makes it illegal to break a website's terms of service (TOS). But these days, most of us break the TOS of the websites and services we use without even realizing it. Every time that coworker Facebooks an inspirational message she found online, she's technically breaking the law. The CFAA was used to threaten internet activist **Aaron Swartz** with 35 years in prison and $1 million in fines for allegedly stealing a trove of academic papers with the intent of making them available freely to the public–he later hanged himself.

In the U.S., we have plenty of policy questions, but few answers. We only have the existing democratic instruments of change: patents, regulation, legislation, and lawsuits. And society is trusting our lawmakers, political appointees, and agency heads to apply those instruments to technologies that could literally change the future of humanity.

What's Next

In a democracy, new policies and laws require discussion, debate and various parts of a government to collaborate. It's a slow process by design, but that doesn't mean we should avoid any action until there's a real crisis. Without meaningful discussion about the long-range implications of legislation, lawmakers could cause drastic (if untended) consequences for their constituents in the decades to come.

Watchlist

Government agencies; business leaders; legal scholars; law enforcement; technology and privacy advocates; media organizations; everyday citizens.

POLICY QUESTIONS WE NEED TO ASK IN 2018

Amy Webb

CAN BOTS BREAK THE LAW?

If a digital assistant or bot breaks a law without your direct involvement—automatically purchasing illegal drugs, or using hate speech against another person—who's to blame? You? The individual developers who created the assistant or bot's code? Or the technology company that built the platform?

DOES THE FOURTH AMENDMENT APPLY TO IPHONES?

Can law enforcement agencies use the Fourth Amendment to compel a company to jailbreak a device?

WHO OWNS YOUR FACE?

Your fingerprint? Your DNA? As consumers voluntarily hand over their bioinformation to for-profit companies, who is the ultimate legal guardian of that data? Can a company take ownership of your DNA and other biodata forever? Can it be given the perpetual, royalty-free worldwide license to our faces?

CAN YOUR FITBIT PLEAD THE FIFTH?

Does the Fifth Amendment mean that wearables—our fitness trackers, connected bras, smart watches—can't be used to self-incriminate us in court?

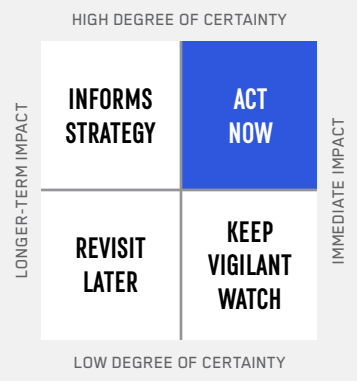
DO ANTI-SLAVERY PROTECTIONS EXTEND TO ALEXA?

Our Thirteenth Amendment declares that "neither slavery nor involuntary servitude, except as a punishment for crime whereof the party shall have been duly convicted, shall exist within the United States, or any place subject to their jurisdiction." It doesn't specifically reference humans. Do anti-slavery protections extend to our artificially intelligent agents?

SECOND YEAR ON THE LIST

Digital Caliphate

219



A #catsofjihad post.

Key Insight

Russia dominated global headlines throughout 2017, perhaps giving us the impression that ISIS had faded away quietly. The threat of a digital caliphate still looms.

Examples

A "caliphate" is a physical Islamic state led by a caliph, a political and religious leader who is deemed the successor to the Islamic prophet Muhammad. In June 2014, the **Islamic State of Iraq and Syria** announced the formation of a geographic caliphate, with **Abu Bakr al Baghdadi**–the head of **ISIS**–as its caliph. However, much of ISIS's most significant work happens in the digital realm. More concerning than the extension of physical borders held by ISIS is the digital spread of its ideas–borders are easy to break. A digital caliphate is hard to stop.

ISIS has risen to prominence because the organization commands social media unlike any other. The Islamic State has developed a magnificently powerful brand–with recognizable characters, plot lines and all the trappings of effective propaganda. It has also routinely fooled social media platforms into allowing its content to resurface, again and again. ISIS understands how to start and stoke a viral campaign, making it difficult to turn off the fire hose. The reluctance of social media companies to stop the spread of misinformation, fake news and extremist messaging is well-documented. Less obvious: their inability to track and thwart, in real time, coded posts. On average, ISIS releases three dozen new pieces of content every day–videos, photos, text posts, tweets, audio clips–in lots of different languages, making it more prolific than many news organizations.

What's Next

The rise of a digital caliphate poses an existential challenge for the world's most important technology companies, all of whom operate out of countries with democratic laws. To thwart the rise of a digital caliphate would necessarily involve censoring content. On the other hand, democratic nations could work together–there is a way to kill an idea, and that's by spreading one that's more compelling.

Watchlist

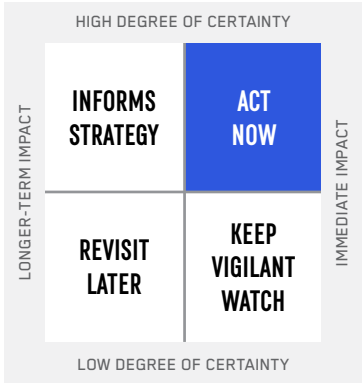
Government agencies; technology leaders; media organizations; ISIS; legal scholars; law enforcement; technology and privacy advocates.

The reluctance of social media companies to stop the spread of misinformation, fake news and extremist messaging is well-documented. Less obvious: their inability to track and thwart, in real time, coded posts.

SECOND YEAR ON THE LIST

Governments Asking Tech Companies To Help Fight the Spread of Misinformation, Propaganda and Terrorism

220



Key Insight

Facebook and **Twitter** were once heralded as instruments of a free and open democracy. However, we learned in the past year that these networks can be hijacked easily by bad actors. Now, government agencies worldwide are expecting tech companies to help fight back.

Examples

In 2017 and 2018 there were several heated **Congressional committee hearings** with representatives from **Twitter**, **Google** and **Facebook**. Committee members demanded that the tech companies admit to platform failures and their role in helping to spread misinformation during the 2016 election cycle.

What's Next

Lawmakers continue to struggle to balance the tensions between censorship, free enterprise and national security. Under **President Barack Obama's** direction, **White House** officials met with the leaders of large technology companies asking them to help "disrupt" **ISIS**'s online presence and activities. In June 2017, **President Donald Trump** convened tech CEOs, asking to discuss modernizing the government's infrastructure and loosening the encryption on consumer-facing devices and services.

But the questions–and answers–are complicated, and they involve all of us. In 2018, governments will lean on big tech companies. Whether or not they can be compelled to play nice is still a legal grey area. Better to debate policy and procedure in advance, so that decisions don't have to be made under duress.

Watchlist

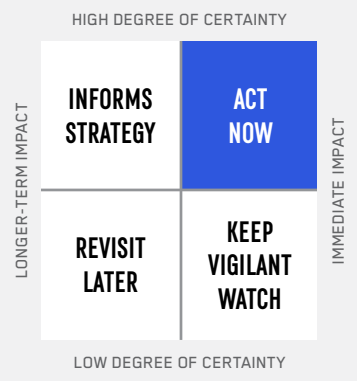
Government agencies; technology company leaders; legal scholars; law enforcement; technology and privacy advocates; media organizations; everyday citizens.

Facebook, Google and Twitter testified in a congressional hearing in 2017.

SECOND YEAR ON THE LIST

Overhauling Government Tech Infrastructure

221



The OSTP was authorized by Congress in 1976 to give the president independent, expert analysis on technology and science policy issues.

Key Insight

Parts of the federal government rely on comically old technology, which is very difficult to maintain. Overhauling the infrastructure has bipartisan appeal.

Examples

In 2017, President Donald Trump asked the CEOs of America's largest tech companies–Apple, Amazon, IBM, Intel, Oracle, Qualcomm, Microsoft, Facebook, Google and others–to help overhaul the government's tech infrastructure. But the idea of overhauling government IT didn't start with the Trump White House. President Barack Obama created the U.S. Digital Service to attract tech sector experts to federal jobs and to fix the broken system from within.

What's Next

In a perplexing about-face, President Trump acknowledged that government systems need to be overhauled–but then didn't name key advisors who would have the authority to make needed changes. **The White House Office of Science and Technology Policy**, which **Congress** authorized in 1976 to give the president "independent, expert judgment and assistance on policy matters which require accurate assessments of the complex scientific and technological features involved" now has no director and maintains only a skeleton staff.

The problem isn't just about legacy systems–it's about keeping pace with the changing nature of technology. In 2016, the **Government Accountability Office** (GAO) published the findings of a sobering technology audit. It found that the **Department of Defense** is using a 53-year-old system and 8-inch floppy disks as part of its nuclear program, while the **State Department** uses a 26-year-old system to track visa information for 55,000 foreign nationals–software that was decommissioned by the vendor who built it.

Old software, machines and systems are expensive to maintain. Plus, there aren't many technicians who have enough institutional knowledge to make the necessary fixes, which means re-hiring retired employees at high contract wages. Legacy systems are also vulnerable to attack.

Watchlist

Federal Chief Information Officer; Office of Science and Technology Policy; Government Accountability Office; Department of Defense; IRS; State Department; Department of Transportation; Department of Justice; Department of Health and Human Services; the FCC; Department of Housing and Urban Development; Department of Energy; Department of Homeland Security; Environmental Protection Agency; Office of Management and Budget; elected officials and lawmakers.

NEAR-FUTURE SCENARIO FOR A MODERN U.S. GOVERNMENT

Amy Webb

THE U.S. JOINS SWEDEN, THE UAE, FINLAND, GERMANY, SAUDI ARABIA IN CREATING A CABINET-LEVEL ROLE FOR FUTURES WORK

Years ago, the now-shuttered Office of Technology Assessment was charged with researching, forecasting and advising Congress on matters of emerging technology. During its existence, the OTA released more than 750 prescient studies ranging from robots in the workplace, to bioterrorism, to acid rain and climate change. The OTA was defunded by Congress in 1995, and it was a mistake. We are building and deploying new technologies at an unprecedented rate. For the first time in our country's history, advancements in science and technology have outpaced our lawmakers' ability to respond in a measured and responsible way.

During the 2018 election cycle, candidates will talk only about technology as it relates to jobs, the economy and better access to government services. That addresses our current problems, not our future ones. We must be developing long-term solutions for technological unemployment, climate change, growing wealth disparities and the shifting nexus of geopolitical power.

A Department of the Future and a Secretary of the Future would advise our nation's top leaders and policymakers on the social, economic and geopolitical implications of emerging science and technology—as those implications relate to all other departments, agencies and offices within the government. The office would coordinate research, lead scenario mapping and long-range planning. And it would ask and answer difficult legal and policy questions about the future of biotechnology, artificial intelligence, autonomous travel, digital divides, renewable energy, space exploration and beyond.

SPACE

FIRST YEAR ON THE LIST

Commercial Space Flight

222

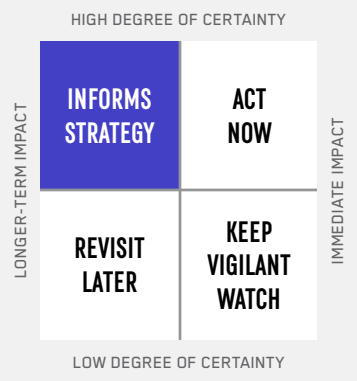


Photo courtesy: SpaceX

The Falcon 9 rocket prepares to land for the second time.

Key Insight

In 2018, test launches will begin for commercial space flight.

Examples

Preparations for commercial space flight are already underway at **SpaceX** and **Boeing** as part of **NASA's Commercial Crew Program**. Both companies are planning to manage six crew missions to the International Space Station between 2019 and 2024. Meanwhile, **SpaceX CEO Elon Musk** has said that he plans to take humans to Mars by 2024. In early January 2018, **Virgin Galactic's VSS Unity** completed its seventh test flight.

What's Next

Not everyone is suited for space flight. **Carl Sagan** wrote about the **"Overview Effect"** in his book **Pale Blue Dot**: "Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves."

There are practical limitations, too: the estimated travel time for a trip to **Mars** and back is currently set at three years. Getting to and from the **Moon** is easier–just one week round trip–but still challenging. Travelers would have to contend with something called "space adaptation syndrome" (like car sickness–but a lot worse) and elevated levels of radiation. One nine-day mission to the Moon would result in radiation exposure equivalent to 35 chest x-rays.

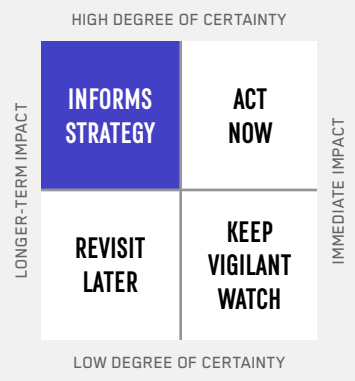
Watchlist

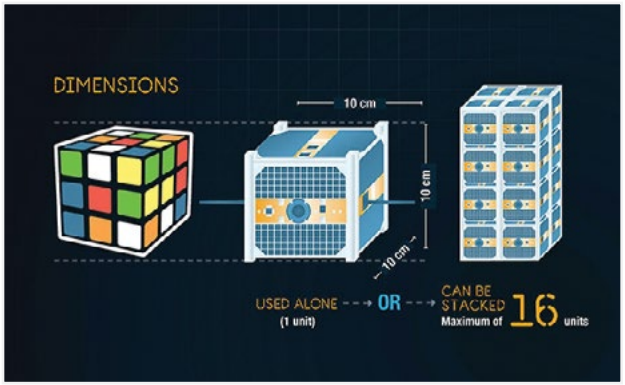
NASA; Amazon; Boeing; European Space Agency; Indian Space Research Organization; Virgin Galactic; SpaceX; China National Space Administration; DARPA; Scaled Composites and Virgin Galactic (The Spaceship Company); XCOR Aerospace; Interorbital Systems; Stratolaunch; Masten Space Systems; Lockheed Martin; Northrop Grumman; Planetary Resources and many more.

THIRD YEAR ON THE LIST

CubeSats

223





Credit: Canadian Space Agency

CubeSats can be used alone or stacked to suit the needs of a specific mission.

Key Insight

Entrepreneurs are building and preparing to launch thousands of low-cost, high-value satellites in the next three years. These satellites are small, capable of communicating with each other, and will photograph every inch of Earth's surface every day of the year.

Examples

Miniature satellites, otherwise known as **CubeSats**, aren't new technology. They've actually been in use by space agencies for years. What's changing is the launch technology that lifts CubeSats into orbit. Heavy investment into propulsion systems—not to mention significant advancements in technology and cheaper components—are making it easier to mass-produce tiny satellites in a factory and launch them for a variety of purposes. Fleets of CubeSats now take photos of farmland and beam them back down to earth to help farmers assess their crops. Image analysis software can tell big box retailers, such as **Walmart**, how many cars are parked in their lots and look for trends over time. They can then do the same with a competitor's parking lots to gather strategic intelligence. Mining companies can survey a swath of land to see who's started drilling and whether they've struck oil. Satellites monitor traffic, polar ice caps, and even us. Unlike a traditional, large satellite, when one CubeSats goes offline or gets damaged, the rest of the fleet still works.

Near-real time images, coupled with machine learning and analysis tools, is big business. Governments, big agricultural corporations, intelligence agencies, shipping companies and logistics firms all want access, so they're willing to pay tens of millions of dollars a year for access. The combined valuation of companies such as **Planet**, **Airbus D&S**, **MDA** and **DigitalGlobe** is well into the tens of billions.

What's Next

The **Federal Aviation Administration** is projecting "an unprecedented number" of satellite launches between 2018-2020. This will allow journalists, companies, governments and private citizens to gain access to the images and tools for all sorts of purposes. CubeSats and image analysis will help us better understand the pulse of our cities, gain a deeper view into weather events and dive into criminal activity. But that goes both ways. CubeSats could become a national security liability.

Watchlist

Space Systems Loral; MDA; Planet; Planetary Resources; Airbus D&S; DigitalGlobe; National Geospatial Intelligence Agency; 3 Gimbals; Space Exploration Technologies Corp; Orbital Insight; Google; SpaceKnow; Capella Space Inc; OneWeb; SpacePharma; Santa Clara University; Technische Universitat Berlin; Tokyo Institute of Technology; University of Tokyo; California Polytechnic University; Cornell University; Boeing; Delft University of Technology; NASA Ames Research Center; Transcelestial; NSLComm; Earthcube; Aerial & Maritime; Fleet Space; Astrocast; Kepler Communications; GeoOptics; Hera Systems; Sky and Space Global; Astro Digital; Kanagawa University; The Aerospace Corporation; Los Alamos National Labratory; NRL Naval Center for Space; Space and Missile Defense Command; Satellogic; Spire; US Air Force; Lawrence Livermore National Labratory; MIT; Shenzhen Aerospace Donganghong; National University of Defense Technology (China); Shanghai Engineering Center for Microsatellites (China); SRI International; Naval Postgraduate School.

FIRST YEAR ON THE LIST

Asteroid Mining For Resources

224

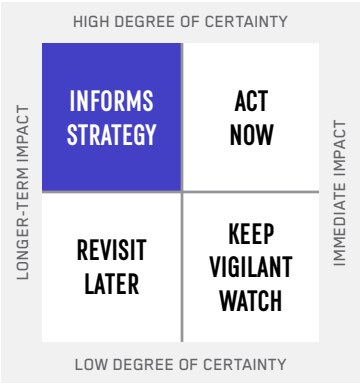


Photo courtesy: OSIRIS-REx Mission

OSIRIS-REx is already en route to the Bennu asteroid.

Key Insight

Mining asteroids for resources will prove invaluable to researchers back on Earth.

Examples

In September 2017, **Arizona State University** astrophysicist **Dante Lauretta** and his team launched the **OSIRIS-REx** to **Bennu**, an asteroid that might offer secrets about the early history of the solar system. It will map the asteroid and return a sample, landing back on Earth in 2023. Also last year, the government of **Luxembourg** passed a law arguing in favor of private companies mining asteroids. Previously, anything above the **Earth's** atmosphere—the **Moon**, the space overhead—has required joint agreements between our various national space agencies and governments. This is an important departure. Essentially, whoever gets to an asteroid first gets dibs on the mineral deposits and, presumably, water.

What's Next

Several companies are planning to send mining equipment and spacecraft to near-Earth asteroids by 2021. The first round of flights will be for prospecting purposes—but there are millions of asteroids overhead. Companies like space mining pioneer Planetary Resources are hoping to build reasonably-priced equipment for companies to send up—essentially, hyper-futuristic shovels and buckets for an impending gold rush.

Watchlist

Planetary Resources; Astrobotic; Government of Luxembourg; NASA; National Geospatial Intelligence Agency; Orbital Insight; University of Tokyo; California Polytechnic University; Boeing; Los Alamos National Labratory; NRL Naval Center for Space; Space and Missile Defense Command; US Air Force; Lawrence Livermore National Labratory; MIT.

SIXTH YEAR ON THE LIST

Space Exploration

225

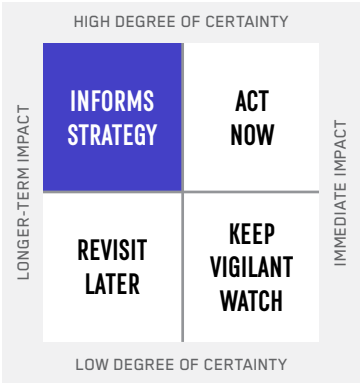


Photo courtesy: NASA

NASA engineers load a structural test version of the Orion Stage Adapter for NASA's Space Launch System onto NASA's Super Guppy Aircraft at the Redstone Arsenal Airfield in Huntsville, Alabama, for delivery to Lockheed Martin in Denver.

Key Insight

We're in the middle of a space exploration boom. Last year, retired **U.S. military officers** confirmed that the government is seeking out and tracking alien life. Startups are working on plans to **colonize Mars**, and they have serious investors. And it looks like humans might be headed back to the moon.

Examples

Pittsburgh-based Astrobotic is developing a lunar lander for commercial use. Anyone wanting to make a lunar delivery just needs to pay $1.2 million per kilogram of payload. Jeff Bezos' Blue Origin, Japanese startup iSpace, and Florida-based Moon Express are all commercial-sector startups planning to fly to the moon and back before 2021. Some of the companies view the moon as "Earth's eighth continent" that could be settled and mined for natural resources. Space agencies from India, China, Japan, the U.S., and also Russia, in a partnership with the European Space Agency, also have plans to land on the moon in 2019 and 2020.

Bigelow Aerospace and **Axiom Space** have both announced that by 2020, they will have built commercial facilities for the **International Space Station (ISS)**. NASA is hoping that the ISS will help support and grow commercial space activities in the near-future as it focuses more of its attention on exploring Mars. **NASA** is also readying the **Space Launch System** in preparation for deep space exploration. The **James Webb Space Telescope**, a massive observatory the size of a tennis court, is nearing completion. Some of the most exciting space innovation is centered deep inside the Mojave Desert, where 17 space-related companies are closing in on commercial space travel, exploration and development.

What's Next

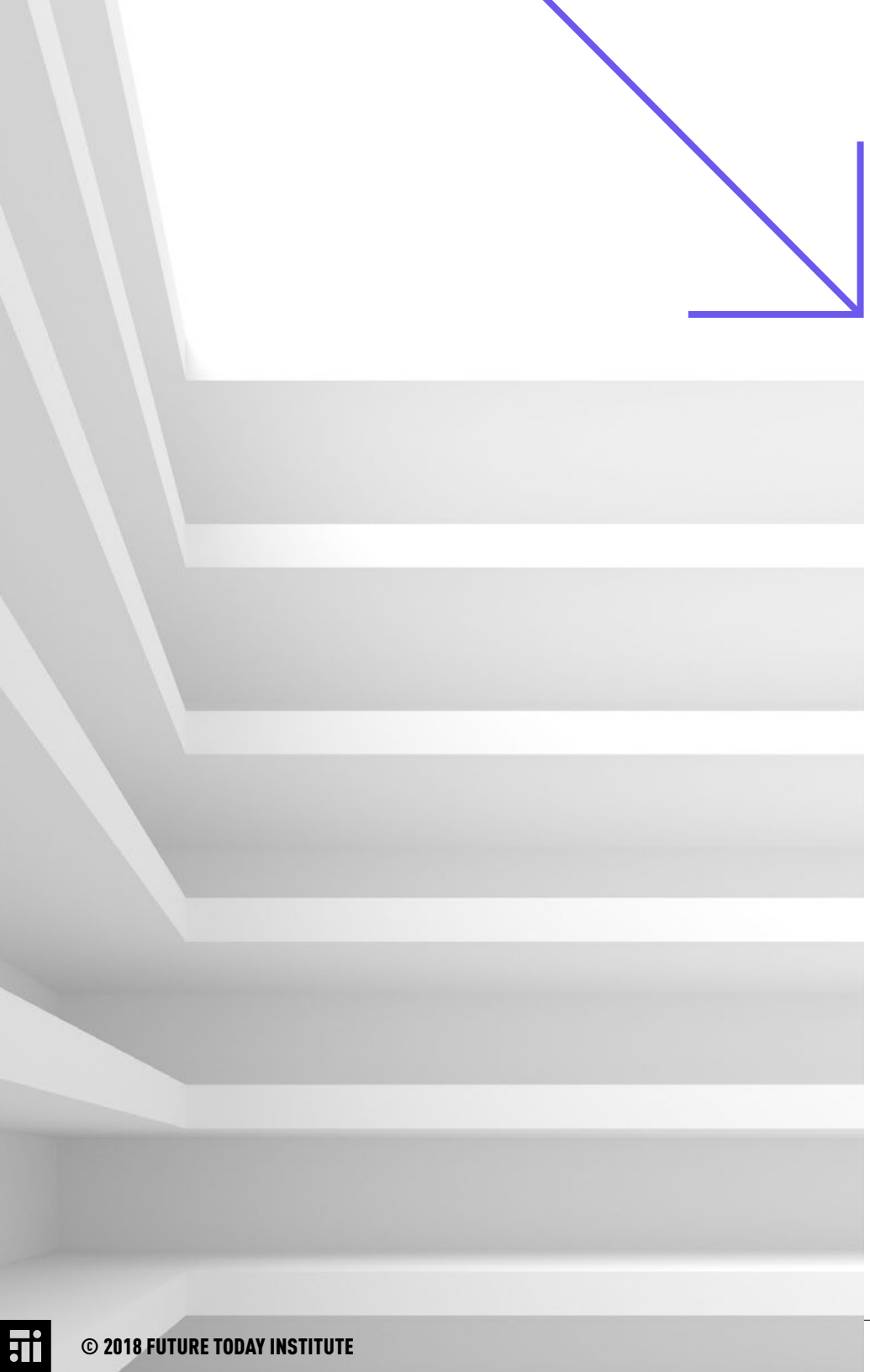
We saw successful (and tragically, some unsuccessful) commercial space launches in the past three years. In January 2018 **Elon Musk's SpaceX** celebrated the **Falcon Heavy** launch as the world watched a **Tesla Roadster**, and the **"Spaceman,"** achieve orbit.

Space agencies in Europe, China and the U.S. are hoping to either land on or get close enough to an asteroid to mine it or change its path. Expect to see humans headed back to the **Moon** and global discussions about whether or not we should make **Mars** a protected habitat, free of government fighting. **China** and **India** will become major players. Soon, there will be a boom in launch vehicles, landers, probes, rovers, space stations and research craft. We'll also see partnerships formed for asteroid and moon mining and for space manufacturing. There will be ancillary opportunities across industries, from durable clothing retailers to skilled manufacturing operations. Private equity firms should start looking at the soon-to-launch companies that will ultimately supply the tools, materials and technologies for commercial space operations.

Watchlist

NASA; Amazon; European Space Agency; Indian Space Research Organization; China National Space Administration; DARPA; Scaled Composites and Virgin Galactic (The Spaceship Company); XCOR Aerospace; SpaceX; Interorbital Systems; Stratolaunch; Masten Space Systems; Lockheed Martin; Northrop Grumman; Boeing; Copenhagen Suborbitals; Orbital Sciences Corporation; Planetary Resources; Samsung; Facebook; Alphabet and many more.

TEN WEAK SIGNALS FOR 2019



WEAK SIGNALS ON THE HORIZON

At the Future Today Institute, our goal in the first step of forecasting is to identify weak signals. Because we know that technology is deeply intertwined with a number of other areas of modern change—the economy, education, government, media, and more—we cannot think about the future of a technology without simultaneously considering movement across all these other areas.

To do this, we use a series of questions to guide our research on emerging technology, science and other areas of change. We categorize our research using a series of nodes and connections. Mapping the fringe forces us to think very broadly—not just about an emerging trend, but how that trend relates to a broader ecosystem. Taking this broader view, where nodes and relationships are both considered in tandem, is critical. This approach can be used to map the fringe for a product or even an entire industry.

The fringe sketch is perhaps the most important part of our forecasting methodology. The goal with the fringe sketch is to get back to zero—to reset the information stage so that it can be fully mapped. The fringe sketch alone does not tell us what the trends are that we should follow. Rather, it positions us to consider all of the possible sources of change ahead.

Here are some of the weak signals we're already listening to for 2019:

01 **Quantum Computers:** In short, quantum computers can solve problems that are computationally too difficult for a classical computer, which can only process information in 1s or 0s. In the quantum universe, those 1 and 0 bytes can exist in two states (qubits) at once, allowing computations to be performed in parallel. Therefore, if you build two qubits, they are able to hold four values at the same time: 00, 01, 10, 11. Quantum computers are not only more powerful than anything built to date—they require special algorithms capable of doing new things. Scientists have been researching quantum computing for decades. The challenge has been proving that a quantum machine is actually doing quantum computations. That's because in a quantum system, the very act of observing information in transit changes the nature of that data.

02 **"Unhackable" Computers:** A University of Michigan team announced plans to develop an "unhackable" computer, funded by a new $3.6 million grant from the Defense Advanced Research Projects Agency. The project involves redesigning microprocessors and computer architecture to avoid the vulnerabilities like Spectre and Meltdown.

03 **Brain-To-Vehicle Interfaces:** Nissan is researching an autonomous vehicle that interprets signals from the driver's brain in order to keep passengers safe and happy.

04 **Brain-To-Internet Interfaces:** One of Elon Musk's more interesting ventures is Neuralink, which would create a "digital tertiary layer" to augment the brain's current cortext and limbic layers. In short, it would connect our brains to the internet and could allow us to achieve super-fast, super-human thinking.

05 **Alt-Cryptocurrencies:** There are hundreds of cryptocurrencies, some of which use their own native blockchains. Ripple, Bitcoin Cash, Bitcoin Classic, Litecoin, Ethereum, Monero, Dash and IOTA are just a few.

06 **Adaptive Camouflage:** Researchers are experimenting with electromagnetic and audio waves, tiny lenses that bend light and reflective materials to hide objects in plain sight.

07 **Robot Vision:** UC Berkeley researchers developed a robotic learning technology that enables robots to imagine the future of their actions so they can figure out how to manipulate objects they have never encountered before. It could help self-driving cars anticipate future events on the road and produce more intelligent robotic assistants in homes.

08 **4D Printing:** Objects printed in 3D that have the ability to morph into different shapes when exposed to changes in light, temperature or humidity.

09 **5D Printing:** This is the name for five-axis additive manufacturing—rather than printing in flat layers, as we do today, this new technique prints curved layers, making the final product much stronger. Much of the research on 5D printing is being done at the Mitsubishi Electric Research Labratories.

10 **Real-Time Language Translation:** Several new headphone prototypes, including Google's Pixel Buds (already for sale) promise real-time, in-ear translation. While headphones could eventually put translators out of a job, they could—theoretically—mean better communication between all humankind.

ABOUT THE AUTHORS

Lead Author

Amy Webb

Amy Webb is a quantitative futurist. She is a professor of strategic foresight at New York University's Leonard N. Stern School of Business and the Founder of the Future Today Institute. Webb was named to the Thinkers50 Radar list of the 30 management thinkers most likely to shape the future of how organizations are managed and led and won the 2017 Thinkers50 RADAR Award. She is the bestselling, award-winning author of *The Signals Are Talking: Why Today's Fringe Is Tomorrow's Mainstream*, a book about how to find and track trends.

Co-Authors

Roy Levkovitz

Roy Levkovitz is a strategist and business development specialist who focuses on strategic foresight and the design and development of technology and its role in supplementing the human experience rather than solely supplanting it. He graduated from Emory University with a degree in Political Science and is a May 2018 MBA candidate at New York University's Leonard N. Stern School of Business.

Kristofer Perez

Kristofer (Kriffy) Perez is a management consultant with a decade of experience in financial services across Europe and the Americas. He specializes in strategic foresight, customer-facing innovation and product strategy. Based in New York City with over 15 patents filed, he is a global entrepreneur who seeks to define how technology impacts society. He graduated from Lehigh University with degrees in Mechanical Engineering and Business and is a May 2018 MBA candidate at New York University's Leonard N. Stern School of Business.

Researchers

Kara Lipsky

Ryo Hashimoto

Ryan Schwartz

Editing

Cheryl Cooney

Creative Direction and Design

Emily Caufield

ABOUT THE FUTURE TODAY INSTITUTE

Founded in 2006, the Future Today Institute helps leaders and their organizations prepare for complex futures. We focus exclusively on how emerging technology and science will disrupt business, transform the workforce and ignite geopolitical change. Our pioneering, data-driven forecasting methodology and tools empower leaders to make better decisions about the future, today.

Our forecasting methodology has been featured in the *MIT Sloan Management Review* and in the *Harvard Business Review,* and it is taught at universities around the world. FTI clients and partners include government agencies, Fortune 100 companies, investment firms, news and entertainment media organizations and associations. Our focus is technology, and we intentionally work with a wide variety of organizations to enable the transfer of knowledge and best practices across industries.

Reliable strategic foresight depends on both ingenuity and rigorous evaluation. Our work is always done in teams comprised of trained futurists as well as subject-area experts, technologists, designers, process-thinkers and creative minds. FTI is based in New York City and Washington, D.C.

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The Future Today Institute's 2018 Tech Trends Report relies on data, analysis and modeling from a number of sources, which includes: sources within public and private companies, securities filings, patents, academic research, government agencies, market research firms, conference presentations and papers and news media stories. This report stems from the Future Today Institute's annual Trends report, which is now in its 11th year of publication, and from the Institute's 2018 Tech Trends For Journalism Report. FTI's reports are occasionally updated on the FTI website.

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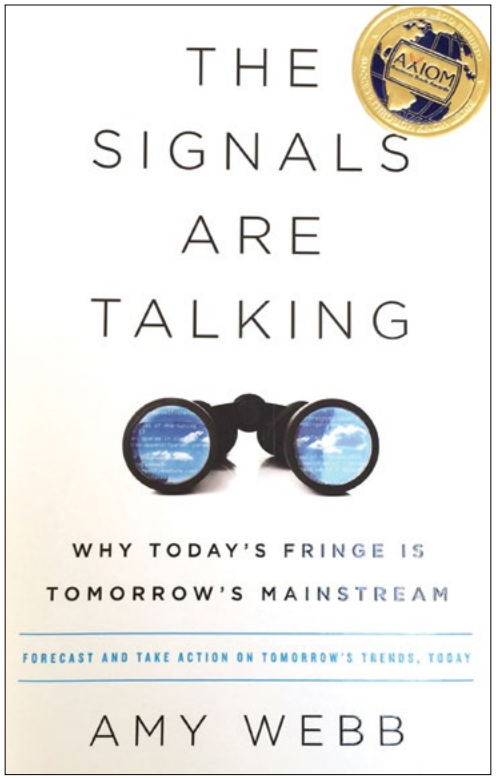
WE INVITE YOU TO LEARN AND USE THE TOOLS OF A FUTURIST.

Amy Webb's new book: **THE SIGNALS ARE TALKING: Why Today's Fringe is Tomorrow's Mainstream** arrives at a fortuitous moment, as it gives critical guidance on how to think like a futurist in order to most accurately answer pressing questions about the future of emerging technologies, science, our economy, political systems, and civil liberties.



- Washington Post Bestseller
- 2017 Thinkers50 Radar Award Winner
- Winner, 2017 Gold Axiom Award
- Fast Company's Best Books of 2016
- Amazon's Best Books of 2016

"A rare treasure: a substantive guide written in a narrative that's a delight to read."

–Christopher Graves, Global Chair, Ogilvy Public Relations

"[The Signals Are Talking] provides several brain-bending future possibilities...Webb's stellar reputation in this red-hot field should generate demand."

–Booklist

"A logical way to sift through today's onslaught of events and information to spot coming changes in your corner of the world."

–KIRKUS

Companies, Organizations, Universities and Government Agencies Mentioned In Our 2018 Trends Report.

3 Gimbals
360 Profilms
3M
ABB Robotics
Abundant Robotics
Accent Advanced Systems
Activision Blizzard Entertainment
Adler Seeds
Adobe
Advance Publications
Advanced Media
Aeon
Aerial & Maritime
Aerion
AeroFarms
AeroVironment
Aethon Inc.
AGCO
Agria Corporation
Airbnb
Airbus D&S
Alcon
AlgorithmWatch.org
Alibaba
Alico Incorporated
All Nippon Airlines*
Alliance For American Manufacturing
Allscripts
Alltech
Alphabet
altMBA
Amazon
American Enterprise Institute
American Express*
American Vanguard
AMY Robotics
Android
Annenberg School of Communication & Journalism
Anthropocene Working Group
Apis Cor
Apple
Arc Group
Archer Daniels Midland
Arduino
Arizona State University
ARP
Arria NLG
Aruba
Asahi Shimbun Company
AstraZeneca
Astro Digital
Astrobotic
Astrocast
AT&T
Atlantica Yield PLC
Atmel
ATR Intelligent Robotics and Communication Laboratories
Audioburst
Auphonic
Aurora Labs
Austrian Institute of Technology
Autodesk
Automated Insights
Autonomous Solutions
AVEBE
Avrio
Axel Springer
Axonify
Azavea
Backchannel
Baidu
Banco Santander
Bank of America
Baseload Renewables
BASF
Bayer AG
BBDO
BBH
BBVA
Beam
Bernard Matthews Farms
Bertelsmann
Bing*
Bioinspired Intelligent Mechatronics Lab at Ritsumeikan University
Bitdefender
Bitnation
Bitter Southerner
Blink CarCharging
BLIP Systems
Blis

Bloomberg
Blue River Technology
Blue Sense Networks
BlueCats
Bluedot
Boeing
Bombardier Phillips
Boston Dynamics
BP
Bright Farms
Brown Institute at Columbia University
Buddy
California Polytechnic University
Caliper
CalSTRS
Caltech/MIT Voting Technology Project
Cambridge Analytica
Camera Culture Research Group at the MIT Media Lab
Canadian Solar Inc
Capella Space Inc
Capital One
Cardano
Cargill
Carnegie Mellon University
Carrefour
Case Western Reserve University
CBS Television
CCP Games
Center for Internet and Technology Addiction
Center For Migration Studies
Central Banks
Central Intelligence Agency
Cerner
ChargePoint
Chartbeat
Chevron Corporation
Chiba University
China National Petroleum Corporation
China National Space Administration
Circos VR
Cisco*
Citibank*
Claas
Clara Foods
Clear
Cluster
COEX
Cognitive Horizons Network
Coinbase
Coindesk
College of Charleston
Columbia University's Earth Institute
Comcast NBC Universal
Conoco Phillips
Consumer Physics
Copenhagen Suborbitals
Coral Project
Cornell University
Counterparty
Coursea
Cox Media Group*
Critical Mass
CropEnergies AG
Crowd Companies Council
Crunchfish
Crystal
Curio.io
CVS
CyLab Biometrics Center at Carnegie Mellon University
Daegu Gyeongbuk Insistute of Science & Technology
Dana-Farber Cancer Institute
DARPA
DataONE
Deep VR
Del Monte
Delft University of Technology
Denso
Department of Computing Science, University of Aberdeen
Department of Transportation
Design Lab
Detroit Dirt
Dexcom
Didi Chuxing
DigitalGlobe
Discovery Communications
Disney
DJI
DNV GL
Dong Energy
Dow Chemical Company
DowDuPont
Dreambox
Droga5
Duke University
Duke University's Center for Neuroengineering
E.W. Scripps
Earthcube
eBay Enterprise
eCFA
eClinicalWorks
Eddystone
Eifer Elektro Firma
Electronic Arts
Electronic Frontier Foundation
Emerson Electric
Energid Technologies
Energous Corp
ENOVA
Environmental Justice Foundation
Envision Solar
EPFL
Epic Games
EPSON Robotics
Ericsson
ESA Data Registry
ESPN
Estcoin
Estimote
Ethereal Machines

Companies, Organizations, Universities and Government Agencies Mentioned In Our 2018 Trends Report.

Etsy
European Geosciences Union
European Space Agency
European Union
Everwise
Exeq
ExOne
Expect Labs
Exxon Mobil
eyeSight Technologies
Facebook
FaceTec
Falabella
FAMA
FANUC Robotics
FarmLink
Festo
FFRRobotics
FICO
Fidor
Finless Foods
First Solar Inc
Fleet Space
Fluidinfo
Formlabs
Founders Fund
Freescale Semiconductor
Frist Wind Solar
Fujitsu
Funding Circle
Future Meat

Gannett
Garage Band
GCL-Poly Energy Holding Ltd
GE
GE Aviation
GE Healthcare
Geekbot
Geekie
Gelo
General Motors
GeoOptics
Georgia Institute of Technology
Gimbal
Glimworm Beacon
Global Cyber Alliance
Global Pvq SE
GoBank
Goodby Silverstein & Partners
Google
Google Play
Government of Luxembourg
Grand View Research
Graphenano
Grove Labs
Grupo Globo
GSD&M
GSK
Hadoop
Hampton Creek
Hanergy Thin Film Power Group Ltd
Harmonix

Harvard University's Biodesign Lab
Harvard University
Harvard University's Wyss Institute
Harvard-MIT Division of Health Sciences and Technology
HarvardX
Hearst Corporation
Hearst Ventures
Helios Interactive
Hera Systems
Hershey's
Hiangsu Akcome Science & Technology Co.
HireVue
Hitachi
Holvi
Home Depot
Honda
Honeywell
HP
HQSoftware
HSBC
HTC
Huawei
Hubert Burda Media
Hulu
HumanAPI
Hyperledger
Hyve
IBM
IBM Research*
IBM Watson*

IFTTT

ILMxLAB

Imax

Imperial College London

Impossible Burger

Inception VR

Indian Space Research Organization

IndoorAtlas

Industrial Light and Magic

Infineon Technologies

ING

Ingenico

Innerspace VR

Inox Wind

Instagram

Institute of Anthropomatics & Robotics at the Karlsruhe Institute of Technology

Insurance companies

Intel

International Monetary Fund

Internet Archive

Interorbital Systems

Interviewed

Intrepid

Intuit

Investigative Reporters and Editors

Ionity

Iowa Farm Bureau

IrisVR

iRobot

ISIS

Iwatani Agrigreen

iZettle

Jabil

Japan Airlines

Japan Plant Factory Association

Japanese Ministry of Economy, Trade and Industry

Jaunt

John Deere

John Deere Labs

Johns Hopkins Applied Physics Laboratory

Johns Hopkins University

Johnson Controls

JPMorgan Chase

Kanagawa University

Karlsruhe Institute of Technology

Kawasaki Heavy Industries

Keonn

Kepler Communications

KeyBank

Khosla Ventures

Klarna

Knewton

Knowledge Network for Biocomplexity

KnuEdge

Kodak

Koenn

Komatsu

Komlep

Kongsberg

Kontakt.io

KUKA

Kuwait Petroleum Corporation

Lausanne and Sant'Anna School of Advanced Studies

LawnLove

Lawrence Livermore National Laboratory

Leap Motion

Lenovo

Leo Burnett

LexisNexis

LG

LHV

Libsyn

Light Sail VR

LinkedIn

Litecoin

littleBits

Lloyds

Lockheed Martin

Los Alamos National Laboratory

Lowes

Lukoil

Luxe

Lyft

Macromedia University of Applied Sciences

Magic Leap

Mailchimp

MakerBot

Marrone Bio Innovations

Massachusetts General Hospital

Masten Space Systems

MasterCard*

MatchMaker Exchange

MatterMost

Mattersight Corporation

MDA

Media Change and Innovation Division at the University of Zurich

Meditech

Meekan

Megvii

MemoryMirror

Memphis Meats

Meredith

Microbiome Center at the University of Chicago

Microsoft*

Microstar

Mistubishi

MIT

MIT Computer Science and Artificial Intelligence Laboratory (CSAIL)

MIT Department of Materials Science and Engineering

MIT Media Lab

MIT's Interactive Robotics Group

Mitsubishi Electric

Mitsubishi Heavy Industries

Mobike

Mobileye

Monero

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Monsanto
Monzo
Morpho
Motech
Motorola
mPesa
MuleSoft
N26
Nanyang Technical University
Narrative Science
NASA
NASA Ames Research Center
National Academy of Science
National Association of City Transportation Officials (NACTO)
National Association of Manufacturers
National Center for Atmospheric Research
National Conference of State Legislatures
National Cybersecurity Alliance
National Emergency Address Database
National Federation of Agricultural Cooperative Association (Japan)
National Geospatial Intelligence Agency
National Institute for Computer-Assisted Reporting
National Instruments
National Oceanic and Atmospheric Administration (NOAA)
National Public Radio
National Science Foundation's Expeditions in Computing Program
National Security Agency
National University of Defense Technology (China)
Nautilus
Naval Postgraduate School
NEC
NeighborGoods
Netflix
Neuralink
New Inquiry
New York Times
News Corp
Nextar Broadcasting Group
NextVR
Nielsen
Nissan
NOAA
Northrop Grumman
Northwestern University's Feinberg School of Medicine
Novartis
Noveto
NovoEd
NRL Naval Center for Space
NSLComm
Nuance Communications
NuProbe
Nvidia
Oak Labs
Obie
Ocado Technology
Oculus
OECD's International Transport Forum
Ogilvy & Mather
Omega Group
OneWeb
OPEC countries
OpenAg Initiative at MIT
OpenBiome
Openledger
Orbital Insight
Orbital Sciences Corporation
Organovo
Osaka University
Osram
Ossia Inc
Otherside Entertainment
Oxford University
Pacific Ethanol
Pacific Standard
Panasonic
PayPal
Pearson
Peerspace
Peking University
Penn State University
Perception Squared
Petro China
Philip Merrill College of Journalism at the University of Maryland
Pie

Planet

Planetary Resources

Plantix

PlantVillage

Playful Corp

PlugShare

Plum

Pocket

PointGrab

Polytechnical University (China)

PoshMark

Postmates

Potsdam Institute for Climate Impact Research

PredPol

Presidential Commission on Election Administration

PRI

Princeton University

ProPublica

Prospera

PRX

Purdue University

Pyreos

Qstream

Qualcomm

Quorum

Raycom Media

Raytheon

Razorfish

REDEF Group

Renewable Energy Group

Rent The Runway

Research Center on Information Technologies (CiTIUS), University of Santiago de Compostela, Spain

Reverge VR

Rewind

Ripple

Rithmio

Robotshop

Rocket.Chat

Royal Dutch Shell

Royal Farms

Rutgers University

Ryukoku University

Salesforce*

Samsung

SANParks Data Repository

Santa Clara University

Sapienza Università di Roma

Satellogic

Saucy

Saudi Arabia Government

Saudi Aramco

Scaled Composites and Virgin Galactic (The Spaceship Company)

Schneider Electric

School of Informatics University of Edinburgh

School of Science and Engineering, University of Dundee

Scribendi

Scuola Superiore Sant'Anna

Seateroo

SEC

Seegrid

SemaConnect

SENS Research Foundation

SenseTime

Sensible Vision

Sensorberg GmbH

Sewbo

Shanghai Engineering Center for Microsatellites (China)

Shapeways

SharedStreets

Sharp

Shenzhen Aerospace Donganghong

Shinpo Electronics

Shodan

Sinclair Broadcast Group

Sinopec

SkillSurvey

Sky and Space Global

Skype

Slack

SmartThings

Snap

SoftBank

SoftBank Capital

SoftBank Group

SoftBank Robotics Corporation

Softkinetic

SolarCity

Solidity

Sony

Sony CSL

Sony PlayStationOrbus VR

SoundCloud

Space Exploration Technologies Corp

Space Systems Loral

SpaceKnow

SpacePharma

SpaceX

Sparkbox

SpeakPipe

Spire

Square

SRI International

Standup Alice

Stanford Computational Journalism Lab

Stanford University

Stanford University Computational Imaging Lab

Stanford University School of Medicine

Stanford University's Sonnenburg Lab

StarLab

StartVR

Steel Crate Games

Steemit

Stitcher

Companies, Organizations, Universities and Government Agencies Mentioned In Our 2018 Trends Report.

Stratasys
Stratolaunch
Style Lend
Suncor Energy
Sungenta
SuperMeat
Survios
Swedbank
Symantec
Syngenta
Synopsys
Tactio
TaKanto VR
Talent Sonar
Tamedia
TDBank
Technische Universitat Berlin
Tencent
Tesla
Texas Instruments
Texas Tribune
Thalmic Labs
The Aerospace Corporation
The American Gastroenterological Association Center for Gut Microbiome Research & Education
The American Gut Project
The Coral Project
The Information
The International Union of Geological Sciences
The Nature Conservancy
The Onion
The Roosevelt Institute
The Royal Society for the Encouragement of the Arts, Manufacturers and Commerce
The Union of Concerned Scientists
The Void
Thingful
Three One Zero
Time Inc
Time Warner
TinyLetter
Tohoku University
Tokai University
Tokyo Institute of Technology
Tokyo University
Tomiyama Corporation
ToolLocker
Tow Center for Digital Journalism at Columbia University
Toyota
Toys Trunk
Transcelestial
TransWest Express Transmission Project
Tronc
Trustify
Tsinghua University
Tufts University
Tumblr
Twilio
Twitch
Twitter
Tyson Foods
U.S. Air Force*
U.S. Army Research Office
U.S. Census
U.S. Congress
U.S. Department of Defense*
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Homeland Security
U.S. Department of Housing and Urban Development
U.S. Department of Justice
U.S. Department of State*
U.S. Environmental Protection Agency
U.S. Federal Communications Commission
U.S. Federal Trade Commission
U.S. Food and Drug Administration
U.S. Geological Survey
U.S. Government Accountability Office
U.S. House Armed Services Subcommittee on Emerging Threats and Capabilities
U.S. Internal Revenue Service
U.S. National Science Foundation
U.S. Office of Management and Budget
U.S. Office of Naval Research
U.S. Office of Science and Technology Policy*
Uber

uBiome
Ubisoft
UBS
Udacity
ULC Robotics
Ultivue
Unacast
UNHCR
United Nations
United Nations Food and Agriculture Organization
United Nations' Intergovernmental Panel on Climate Change
University College Cork
University College London
University Hospital Agostino Gemelli
University of Birmingham
University of British Columbia
University of California at Berkeley's School of Information
University of California at Los Angeles School of Engineering
University of California at San Diego
University of California Berkeley
University of California Los Angeles
University of California-Davis
University of California-Irvine
University of California-Santa Barbara
University of Cambridge
University of Chicago
University of Connecticut School of Medicine
University of Illinois Urbana
University of Maastricht
University of Maryland
University of Massachusetts
University of Michigan
University of New Mexico
University of New South Wales (Australia)
University of North Carolina at Wilmington
University of Pennsylvania
University of Pennsylvania's Nano/Bio Interface Center
University of Southern California
University of Stuttgart
University of Texas
University of Texas at Austin
University of Tokyo
University of Washington
University of Washington's Center for Sensorimotor Neural Engineering
Univision
USAA
USC Robotics Research Lab
USDA
Valero Energy
Validic
Valve
Vayable
Verily Life Sciences Verizon
Vestas
Vestas Wind Systems
VEX Robotics
Viacom
Vice
Viome
Virgin Galactic
VirtualSKY
Visa*
Viveland
Vivify
VML
Vox
Voxeljet
VRNISH
VRX Networks
Walgreens
Wall Street Journal
Walmart
Washington Post
Wawa
Wayfair
Waymo
WeChat
Weiden+Kennedy
Wells Fargo
Wevr
WeWork
Worchester Polytechnic Institute
Workbot
World Bank
World Health Organization
World Resources Institute
X.ai
XCOR Aerospace
Xiaomi
Xinjiang Goldwind Science and Technology
Y-Combinator
Yahoo
Yamaha
Yomiuri Shimbun Holdings
YouTube
Zaaryl
Zeiss
Zelle
Zendesk
ZeroLight
Zuercher

CONTACT INFORMATION

The Future Today Institute

hello@futuretodayinstitute.com

267-342-4300

www.futuretodayinstitute.com

2018 TECH TRENDS REPORT

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