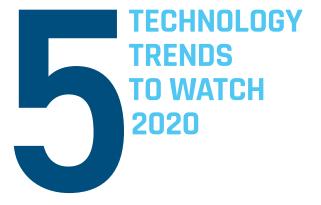
TECHNOLOGY TRENDS TO WATCH







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TECHNOLOGY TRENDS TO WATCH 2020



ACCESSING THE LANDSCAPE

he future is ripe for disruption with technology as the catalyst. Although disruption is often uncomfortable, it creates a pathway to new growth. And pioneering technologies such as artificial intelligence, quantum technology, virtual reality, augmented reality and real-life applications of 5G are helping to fuel this growth. In fact, CTA's U.S. Consumer Technology Sales & Forecasts biannual report expects the consumer technology industry to cross the \$400 billion threshold in 2019 — smashing all previous records and helping to support more than 18 million American jobs.

Because technology is redefining the world, each year the Consumer Technology Association's (CTA) *Five Technology Trends to Watch* publication selects five topics to explore how these promising areas could impact our future. For the 2019 edition, we focus on tech tackling therapy in the digital health space; what is coming next in transportation; the future of food; how facial recognition is impacting the world and robots that will continue to improve lives.

As North America's largest technology trade association, CTA represents the world's leading innovators — from startups to global brands. CTA owns and produces CES® — the largest, most influential tech event on the planet giving each of us a front row seat at the center of innovation. CES has long been a must-attend event for cutting-edge tech firms, including IBM, Intel, LG, Microsoft, Panasonic, Qualcomm, Samsung and Sony.

But today, technology is woven into every industry. From top consulting firms, to travel, defense, agricultural and insurance companies, many traditional companies are choosing to make their mark at CES, repositioning their businesses to become more tech-oriented — think Carnival, John Deere, Coldwell Banker and nearly every car company.

CES gives us a glimpse of a wonderful future: drones that deliver medicine to remote places or search for missing people; cars that avoid accidents; wearables that tell us about health, sleep and exercise and help the elderly live independently; sensors that tell farmers how much to fertilize or water; and 3D printers for our home that soon will make almost anything we can imagine.

To learn more about the vibrant innovations enhancing our lives, I invite you to come to CES 2020 on January 7-10, the world's innovation showcase, to see the products, technologies and services that are solving real problems and improving the lives of global citizens. For more information, visit CES.tech. See you in Las Vegas!

An Smi

Gary Shapiro
CTA President and CEO



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TECH TACKLING THERAPY

BY VERONICA LANCASTER

am a military veteran, having served five years in the U.S. Army. I come from a family that values the importance of military service. My father retired after 20 years in the U.S. Air Force and my brother is actively serving in the Marines for more than 20 years. I was young when I joined the Army and didn't fully grasp that service could mean war. But nearly a year after I joined, the first Persian Gulf War conflict started. I had friends in Airborne units that were sent to active combat in the Middle East. They were scared. I was scared. Would they be safe? Could I be going next?

Who could have predicted that years later, we would still be locked in active combat for 18 years? The first Gulf War lasted only a matter of months, and most soldiers were not deployed into active combat. That's not the case for today's military. My brother has been serving in active combat throughout his career, during Operation Enduring Freedom (2001–14) and Operation Freedom's Sentinel (2015–present). He's a touging and not one to admit fear, as is the case for many soldiers, but he's been deployed many times over the past 18 years. These deployments take a toll on soldiers and the families. Seeking help is a struggle as it can falsely appear as a sign of weakness, which is especially difficult for soldiers who are hyper-focused on advancing in their careers in

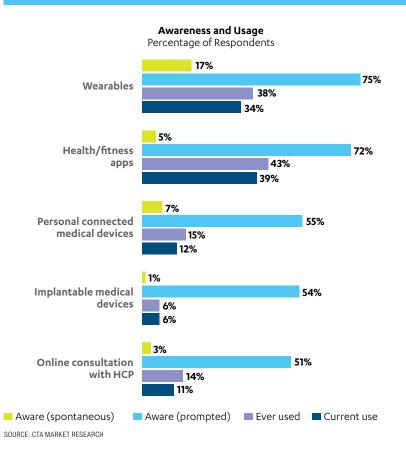
a competitive area. Even though this is not unique to veterans and we've evolved into a more accepting society, there is still a stigma associated with mental health or addiction, which can hinder an individual from seeking help. This is an area where technology can and is helping.

Growth and Consumer Acceptance in DTx

According to Torsten Maschke, CEO of Datwyler Sealing Solutions, more than 300 million people will use a wearable device for health and wellness tracking by the end of 2019. With this large market, making a distinction between wellness products, digital health and digital therapeutics helps create consumer understanding in the capabilities of this technology.

Digital Therapeutics (DTx) has been explored in the 2015 and 2019 editions of *Five Technology Trends to Watch*, with predictions that new technologies were poised to disrupt the health care market. Wearables are giving consumers insight into their health, fitness and wellness. The Digital Therapeutics Alliance made a distinction between the terms "digital health" and "digital therapeutics." Digital health is a comprehensive term describing technology that engages patients for health-related purposes. DTx is an independent category in that its primary function is delivering therapeutic interventions via software directly to the patient to prevent, manage and treat a medical disorder or disease. This distinction is welcome as CTA's research *Assessing the Landscape for Digital Therapeutics* identified the need for a universal definition of DTx to differentiate it from digital health.

Wearables and health/fitness apps lead the way in both awareness and current use



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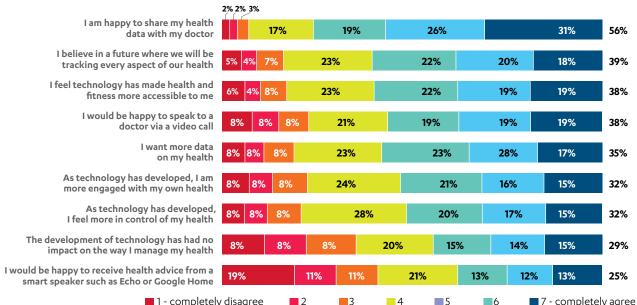
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Consumers are becoming more aware of health technology such as personal health connected devices, implantable medical devices and online telemedicine appointments with physicians, according to CTA's recent research Connected Health and Remote Patient Monitoring: Consumer and Industry Use, released in February 2019.

SOURCE: CTA MARKET RESEARCH

According to a 2019 digital health consumer survey by Accenture, more than half of consumers surveyed expect digital capabilities from their health providers in 2019, and these expectations influence how patients choose a provider. When asked if a variety of electronic capabilities would increase the likelihood of choosing that provider,

Influence of the Development of Technology in Relation to Managing Own Health Percentage of Respondents Consumers are willing to share their health data with their doctor as technology provides easier access and increases engagement with their health



Future of Standards for Wearables

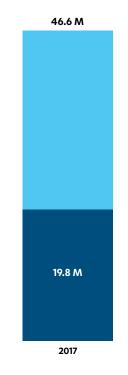
Standardization can help alleviate doubts consumers have in the various wearable devices and apps, especially given that some require no validation and make unsubstantiated claims. The variance in the claims of these apps and devices could be better sorted through establishing baseline minimum quality requirements for different categories of wearables. Continued clinical research and evidence, as well as FDA approval of software used as DTx, will also help distinguish different classes of wearables.

49% of respondents were interested in video appointments with their providers while 53% of respondents were interested in using remote or telemonitoring devices to record and monitor health. Accenture also reports that 29% of respondents have used some form of virtual care, which is a 21% increase from their 2017 data.

Increasingly, consumers are willing to share their health data with their physicians, becoming more engaged in their health care, and can see a future where more of their personal health information will be trackable via wearable devices

The diversity of DTx products has allowed product developers to focus on solutions to complex problems like mental health, PTSD or battling the opioid epidemic. Reimbursement has been a barrier to the adoption of this technology but this is slowly changing. Developers are seeking FDA approval for their therapies, and there is more clinical evidence of effectiveness. Reimbursement and payment for DTx is still a challenge to wider adoption by clinicians. Developers can also consider licensing fees, data collection and selling of data, but must consider anonymizing data and data security.

Out of 46.6 million U.S. adults with a mental illness, only 19.8 million sought treatment in 2017.



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Behavioral Health Demand and Supply

In 2025, demand for psychiatrists may outstrip supply by anywhere from 6,000 to 15,000 or 25%, according to a 2017 National Council for Behavioral Health report that explores the shortage of psychiatrists and suggests solutions. People are more aware of mental health problems and are seeking treatment. Mental health providers are reimbursed less than physical health providers, which can result in a struggle to cover salaries. A 2015 report by the American Academy of Medical Colleges states that more than 60% of practicing psychiatrists are over the age of 55 and considering retirement. The traditional model of psychiatric care delivery is unsustainable, as concluded by the National Council for Behavioral Health Medical Director Institute, which opens the door for technology.

Technology is already making a difference, with telepsychiatry allowing primary care physicians and psychiatrists to collaborate, resulting in improvement in patients with depression and anxiety. Technology is also putting the ability to control the condition in the hands of the patient, whether it's aimed at improving mental health or pain management. With the integration of patient-facing apps and clinical dashboards, technology is providing the ability to solve the shortage by seeing more patients during off hours or "on-demand" through 24/7 availability. Artificial intelligence has the potential to create solutions for the shortage of available mental health providers and the associated stigma in that common algorithms can be used to create software or chatbots that assist in screening and coaching, and patients are more likely to be open.

Tech for Vets

Veterans face the struggle of needing to appear strong while dealing with a difficult work environment, which is where technology can provide help by allowing a certain level of anonymity or the ability to seek treatment from the privacy of their homes. By interfacing through a computer or a mobile app, the veteran does not have to go to a clinic. And the Department of Veteran's Affairs is seeing the value of how technology can help.

The White House recently issued Executive Order 13861 forming a task force on veteran wellness, empowerment and suicide prevention, and ultimately creating a plan called the President's Roadmap to Empower Veterans and End a National Tragedy of Suicide (PREVENTS) with a holistic view of preventing veteran suicide. The White House and Department of Veterans Affairs report that veterans are committing an average of 20 suicides per day, with only six receiving VA care. Male veterans ages 18-34 have the highest suicide rate, a key finding the VA notes as a substantial increase from their 2016 VA National Suicide Data Report. This demographic struggles with the stigma associated with getting help but is also tech-savvy, putting technology in a unique position to help.

The suicide rate for veterans is **1.5 times greater** than Americans that never served.

- U.S. Department of Veterans Affairs





CREATIVE TECHNOLOGY'S BRAVEMIND

The VA started using artificial intelligence (AI) algorithms in 2017 to identify veterans that might be at risk for suicide through the review of VA patient records. This algorithm, called Recovery Engagement and Coordination of Health — Veterans Enhanced Treatment (REACH VET), uses predictive modeling and data from records on medications, treatment and use of VA services, experienced trauma and other factors, to identify veterans most at risk for suicide. Once identified, the veteran is contacted by the VA to check on well-being. There are challenges to using AI in this manner, such as flagging veterans that might not want help, flagging the wrong patients, or the potential for discrimination against these patients once they are identified and the information associated with them. But the VA reports that veterans are responding positively to the program.

IBM was recently awarded a contract through the VA to field test and pilot a mobile app called Getting Results in Transition (GRIT), which is focused on employment transition from military to civilian life, but has a secondary use case to gain insight into a veteran's well-being and resiliency based on real-time and consistent personal data collection. The app will use IBM's Watson technology and will consist of active duty service members and veterans. A field test is expected soon, which will monitor how transitioning soldiers maintain social connectiveness and engage with the app.

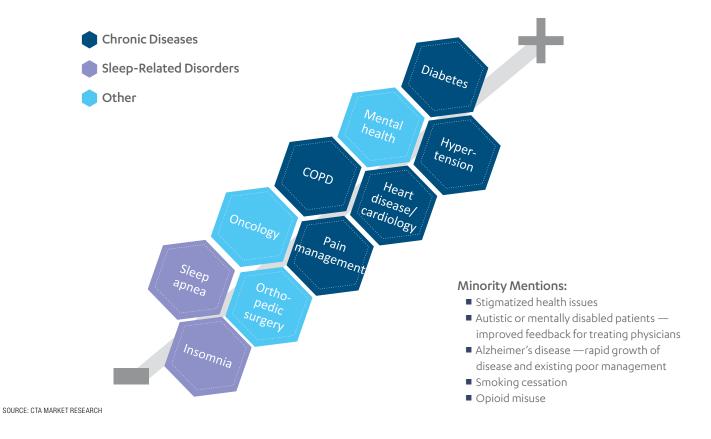
SimSensei (formerly Ellie) is a virtual therapist diagnostic tool that offers PTSD screening and was developed by USC's Institute for Creative Technology. Dr. Albert "Skip" Rizzo, director, Medical Virtual Reality at the Institute for Creative Technologies at the University of Southern California (USC), is involved in both SimSensei and BRAVEMIND. "The SimSensei effort was originally designed to "sense" users' facial expression, gestures, and vocal parameters in interacting with a Virtual Human clinical interviewer and automatically infer their emotional status from those "signals," said Rizzo. SimSensei identifies indicators of psychological distress such as depression, anxiety and PTSD.

"This information is fed back to the Virtual Human interviewer's software to help it respond more genuinely during the interaction with the user. Moreover, these signals can be quantified over a 20-minute interview to provide information about the user's psychological status and perhaps inform future treatment planning. The interesting thing we found was that users felt more comfortable self-disclosing personal information and mental health symptoms to a virtual human compared to when a real person was involved. Users often reported they felt safe having an open conversation with a Virtual Human knowing they would not be judged

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CTA's research identified mental health and pain management as chronic diseases believed to present the greatest opportunity for DTx adoption.



negatively for being honest, as might happen with a real interviewer. While essential for a trained clinician to be present and involved, we do see this technology as useful for filling gaps where a clinician is not available. Thus, SimSensei and other Virtual Human systems may have a future as a useful and engaging approach to breaking down barriers to care for those in need," Dr. Rizzo says.

USC's Institute for Creative Technology is also focused on medical virtual reality (VR) in the treatment of PTSD and created BRAVEMIND as a clinical and interactive virtual reality exposure therapy tool. This multisensory, immersive tool allows a clinician to provide gradual exposure to a traumatic event in a controlled VR environment while monitoring how intensely the patient reacts to the trauma. The clinician can control, document and measure reactions. USC's Institute for Creative Technology is now working with the SoldierStrong veterans' foundation and the VA to provide VR equipment and clinician training to VA medical centers around the country and the software is also available to any site with that has clinicians certified to deliver this form of VR exposure therapy. "The VR exposure approach is designed to help patients with PTSD confront and reprocess difficult emotional memories in a safe place, guided by a well-trained clinician," says Dr. Rizzo.

"The newest iteration of BRAVEMIND now leverages the latest advances in VR display technology and computer processing and is being rolled out on a large scale for addressing the needs of service members and veterans who have suffered from this 'invisible' wound of war. PTSD is not a life sentence and we believe that this approach leverages technology to amplify evidence-based care and have a significant impact on reducing the suffering in those exposed to trauma," he adds.

According to the National Institute of Mental Health, nearly **one in five adults** live with a mental illness.



PE Coach 2 is the latest version of a collaborative care app to treat PTSD created by VA's National Center for PTSD and DoD's National Center for Telehealth & Technology. The PE Coach 2 app is designed to be used in combination with treatment by a therapist and provides the ability for the patient to engage in care through Cognitive Behavioral Therapy (CBT) exercises and homework assignments. Patients can record and reference their therapy sessions, as well as record their personal distress ratings against daily situations, allowing better identification of trigger points.

Substance Abuse and the Opioid Crisis

The U.S. government recently released a roadmap for public comment on how to resolve the opioid crisis. This report, *Health Research & Development to Stem the Opioid Crisis: A National Roadmap* from October 2018, suggests treatment options could include both pharmacologic and non-pharmacologic options. In the fight against the opioid crisis, this could include the development of smart

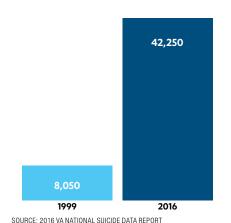
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technology options, such as telemedicine, mobile apps, a combination of digital therapeutics and drug therapy, as well as the involvement of therapists in combination with technology.

The Food and Drug Administration (FDA) recently approved a mobile application to treat substance misuse and dependencies, citing clinical trials that showed 40% of patients using the app abstained for three months, compared to 17.6% of those who used standard therapy alone.

Drug overdose deaths in the U.S. increased from 8,050 in 1999 to 42,250 in 2016.





Pear Therapeutics and Sandoz, a subsidiary of Novartis, are launching ReSET and ReSET-O as the first digital prescription therapeutics for the treatment of substance use disorders. ReSET will be used in the treatment of substance use disorder with a combination of CBT and treatment. ReSET-O is more focused on opioid use disorder in combination with the medication buprenorphine, which is under review by the FDA. The technology uses a patient facing app involving the patient through homework, guizzes, reporting substance use and cravings, as well as triggers. The clinician can monitor patient input and progress via a dashboard.

NeuroMetrix is behind Quell, an FDA-cleared wearable therapeutic device for chronic pain that is available over the counter and 100% drugfree. Dr. Shai Gozani, MD, PhD, founded NeuroMetrix while conducting medical research at MIT. Quell uses transcutaneous electrical nerve stimulation technology to block chronic pain by sending low-voltage electric currents to the brain to generate a natural pain relief response. Quell also provides an app that allows patients to engage in and manage their therapy, track pain levels and other biometrics. The app allows for patient personalization by adjusting stimulation intensity, length of therapy sessions, insight based on personal data gathered, and even weather tracking that could impact pain. The latest version is Quell 2.0, which debuted at CES 2019.

AppliedVR was founded in 2015 and provides therapeutic VR to over 30,000 patients in more than 250 hospitals. A fully immersive and multisensory experience can distract patients from pain. AppliedVR has a library of content to provide experiences that teach coping skills for living with chronic pain, covering topics addressing breathing techniques, mindfulness, psychoeducation and positive thinking.

My Smartphone, My Therapist

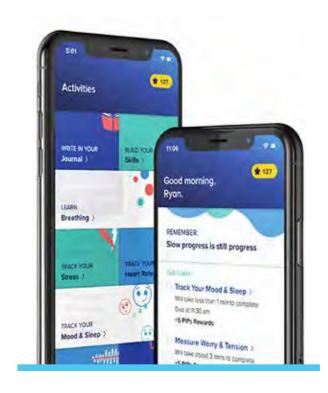
The brilliance of technology in helping people with mental health conditions is that it provides greater privacy, a sense of anonymity and involves patients in their treatment. Patients can seek treatment from the comfort of their own home or from whatever location they desire when they need it, rather than scheduling an appointment or having to go to the therapist directly.

CBT is used to treat a variety of mental health conditions because it's aimed at a person changing their own harmful thoughts, perceptions and patterns of behavior, empowering the patient to challenge and overcome these thoughts through behavior changes and coping strategies delivered through software. Software and apps can provide personalized support based on goal setting, achievements, interaction and coaching.

Pear Therapeutics is developing a DTx called Thrive with Novartis to treat schizophrenia, as well as a DTx called Somryst to treat chronic insomnia and depression, reporting that depression is the most common co-occurring disorder with insomnia. Pear Therapeutics is one of nine companies involved in the FDA software pre-certification pilot program and is focused on prescription DTx supported by data from clinical trials.

To Wrap it Up

CTA's research predicts that DTx will continue to grow. Predictions through 2027 are that technology will advance in a way that provides greater availability of wearable devices with data capture capability, more user-friendly and cost-effective DTx. better and more efficient monitoring of treatment, and such advances will lead to earlier



In 2025, demand for psychiatrists may outstrip supply by anywhere from 6,000 to 15,000 or 25%, according to a 2017 National Council for Behavioral Health report.

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interventions. There are still issues that need to be addressed including reimbursement, clinical evidence to support DTx and a regulatory approval process for DTx.

There is an obvious need that technology can address in providing better and more access to mental health providers, given that we are facing a shortage of available psychologists and therapists. The opioid crisis and human reliance on prescriptions for both pain management and mental health also provide an opportunity. Technology can help people get more involved in their active treatment because it helps them change their behavior and makes it, so they don't have to rely solely on medication. Technology can provide solutions to some of our heaviest problems and help veterans that have given so much in the service of their country.



- Robotics: Current Landscape & Consumer Perceptions
- Connected Health and Remote Patient Monitoring: Consumer and Industry Use
- Active Aging: Consumer Perceptions and Attitudes
- Augmented Reality and Virtual Reality: Consumer Sentiments 2018

CTA's Health and Wellness Standards

- ANSI/CTA-2051, Personal Sound Amplification Performance Criteria
- ANSI/CTA-NSF-2052.1, Definitions and Characteristics for Wearable Sleep Monitors
- ANSI/CTA/NSF-2052.2, Methodology of Measurements for Features in Sleep Tracking Consumer Technology Devices and Applications
- ANSI/CTA/NSF-2052.3, Performance Criteria and Testing Protocols for Features in Sleep Tracking Consumer Technology Devices and Applications

- ANSI/CTA-2056, Physical Activity Monitoring for Fitness Wearables: Step Counting
- ANSI/CTA-2060, Standard for Consumer EEG File Format (Attuned Container Format)
- ANSI/CTA-2065, Physical Activity Monitoring for Heart Rate
- ANSI/CTA-2076, Inclusive, Audio-based, Network Navigation Systems for All Persons including those Who are Blind/ Low Vision

Check https://bit.ly/2kv5ilk for information on work in progress.



Stress Management

CES exhibitors TouchPoint and HEALium are using cutting-edge tech to help consumers manage stress. HEALium leverages virtual and augmented reality travel to allow users to biometrically alter their virtual environment through emotions to decrease their stress. Powered by the user's brain patterns and heart rate, the product lets users "heal" in virtual worlds, promoting the power of the user's positivity and sensations of healing. And TouchPoint uses gentle micro-vibrations called BLAST (bilateral alternating stimulation tactile), to give users a soft vibration that calms the brain. The wearable tech also relieves the body sensations that often accompany stress, such as stomachaches or headaches. At CES 2019, TouchPoint gave realtime EEG scans that illustrated the effect the technology has on the brain. See the latest in tech-based stress management and pain relief at CES 2020.



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WHAT'S COMING NEXT IN TRANSPORTATION — FLYING CARS?

BY ROBERT E. CALEM

veryone's fantasy of a world without traffic may finally be realized, say proponents of a burgeoning flying taxi industry now taking shape around a new kind of aerial vehicle that is a hybrid of a helicopter and a drone, known as a vertical takeoff and landing aircraft, or VTOL. Shepherded by businesses, academics and government officials alike, VTOLs are evolving quickly thanks to many of the same technologies developed for self-driving cars and electric vehicles (EVs) on the ground, including sensors, computing hardware and software, batteries and V2X (vehicle-to-vehicle and vehicle-to-infrastructure) connectivity. And if promises are kept, some of the first flying taxis will be available in just four years, hoisted by ride-sharing industry giant Uber with the service moniker Uber Air.

NASA has defined urban air mobility or UAM as "a safe and efficient system for air passenger and cargo transportation within an urban area, inclusive of small package delivery and other urban unmanned aerial systems (UAS) services, which supports a mix of onboard/ground-piloted and increasingly autonomous operations."

According to a Morgan Stanley Research report published last
December — titled Flying Cars: Investment Implications of
Autonomous Urban Air Mobility — the "total addressable market" for
VTOLs in the U.S. could grow from \$2 billion in 2020 to \$21 billion by
2025 and \$328 billion by 2040. Worldwide, Morgan Stanley projects the
figure to reach about \$1.5 trillion by 2040. These are "Base Case" figures,
according to the report, which noted that the corresponding "bullish"
forecast is \$2.9 trillion worldwide by 2040. The predictions account for
more than just the business of transporting people, however; they also
include revenues generated by other VTOL uses, such as delivering
packages and the supply chain.

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"Urban air mobility represents business opportunities within infrastructure, fleet management, software, hardware and content, much like the opportunity for autonomous vehicles," says Adam Jonas, head of Morgan Stanley's global auto and shared mobility research team.

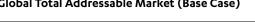
Autonomy is the Endgame

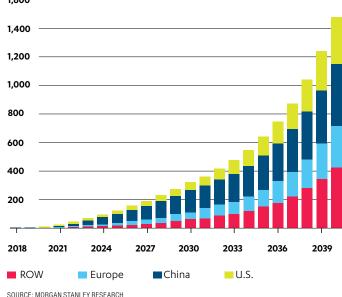
The Morgan Stanley report also refers to VTOLs as "flying cars" and says they would be able to make four trips for each one trip a car on the ground completes, and thus "could revolutionize the ride-sharing industry."

Regardless, the sky-road ahead might not be so easy. There are challenges to overcome before such flying taxi services and other businesses using VTOLs can take off on a mass scale.

"We see a very significant market opportunity" in flying taxis, yet also, "a new ecosystem," says Antonio Campello, president and CEO of EmbraerX, a unit of Brazilian aircraft maker Embraer S.A. that is developing

Urban Air MobilityGlobal Total Addressable Market (Base Case)





electric-propulsion VTOLs (eVTOLS) for Uber. It is also developing an eVTOL maintenance system named Beacon and a UAM air traffic management system for flying taxis in concert with its sister company Atech. "It's not just about the aircraft," Campello says, but rather allowing more aircrafts to fly at the same time and keeping them safely airborne.

For the VTOL craft itself, success will come down to the mix of technologies employed, and makers now have lots of choices, which also present

compromises, he explains. Battery technology is an example; limits to energy density (how much power can be delivered for a given weight) as well as the discharge rate mean deciding between carrying more passengers or flying a greater distance. The vehicle's design must also account for enough power to go the distance of the trip while still ensuring a smooth takeoff and landing, he adds. Moreover, the battery's reliability is key — far more important for an eVTOL than for a regular car because of the risk that a single failure in the sky would cause a fatal accident.

To be sure, the batteries available today do allow VTOLs to come to fruition already, Campello says — athough more evolution is needed, it is progressing.

Urban air traffic management, or UATM, is another area that needs further refinement. And to that end, EmbraerX — the United States' Embraer division — partnered with tech companies Atech and Harris Corp. to connect eVTOLs to the air traffic control systems used by helicopters and airplanes within a city's airspace. The procedures-based paradigm is spelled out in EmbraerX's white paper Flight Plan 2030. It aims to tame air traffic in urban environments by "reducing the workload for voice-based (human-controlled) air traffic management" and inserting automated data-exchange technologies and new concepts, says David Rottblatt, EmbraerX's director of business development and leader of the company's UATM project team.

"The idea of urban air mobility is not new. It's been around since the 1940 and 1950s," Rottblatt says, explaining that what's different now is the electrification of aircraft and resulting lower maintenance costs, which should lead to lower-cost travel and rising demand for these flying taxis. So that this growth isn't stifled, he says, "we need to make sure that we have the right technology and procedures that can enable a broader

and more segmented aircraft community to all work together" in city air corridors.

Giuseppe Loianno, an assistant professor at New York University's Tandon School of Engineering, agrees.

"It's important to find new ways, in three-dimensional space, to move quickly in urban environments," he says. "Certainly, this is something that's going to have a future." Nevertheless, "transitioning from a piloted machine to a pilotless one is very difficult," because autonomy technologies are still not reliable and robust enough to be compatible with current regulations, he says.

To that end, Loianno and his colleagues at NYU Tandon are pursuing three research tracks for technologies that let drones navigate through airspace without the aid of GPS. One focuses on single-drone navigation for search and rescue applications, another on ways to have multiple drones communicate for collaborative navigation, and the third on human-drone interfaces that let a remote operator control a drone's movement with gaze or voice commands. The techniques that will emerge from all three tracks could be applied to autonomous VTOLs used as flying taxis or for other commercial purposes, such as package delivery. It may even be applicable to self-driving cars, Loianno says.

NYU Tandon's solutions use 5G cell connections to localize the drone in 3D space, and each vehicle is its own floating cell tower. Thus, a VTOL could be used to provide connectivity to a self-driving car as well as help it to navigate, he suggests.

But it will be a couple of years before the fruits of NYU Tandon's work can be transferred to industry, Loianno says.

An Assortment in the Sky

A wide variety of autonomous VTOLs are in development, too, including electric and hybrid-electric models. The Vertical Flight Society — a non-profit association for engineers, scientists and others working on VTOLs cites UAM market reports spearheaded by NASA, Morgan Stanley and others that foresee as many as 100,000 eVTOLs flying commercially 20 to 30 years hence. One company pushing to the top of the market is ridesharing giant Uber.

Uber's intention is to have thousands of VTOLs sharing a city's airspace simultaneously. "We're talking about aviation at a scale that never existed before," says Nikhil Goel, head of product at Uber Elevate, the company unit that is working on VTOL development with partners and preparing the Uber Air service. "Our goal is to make traveling by air as economical



The Bell Nexus ducted-fan air taxi at CES 2019.

as traveling by car." And if that's achieved, it will result in cities being built differently, he says, as people rethink where they can conveniently live. "We're focused in areas today that have the maximum congestion and the maximum density. Over time, as [flying taxis] get lower priced and more ubiquitous, is when we will see [these] start to get more widely adopted in places that are more rural and suburbs."

Begun three years ago with NASA-inspired electric propulsion technology as its foundation, Elevate has announced public partnerships with six VTOL makers: EmbraerX, Bell Flight, Aurora Flight Sciences (a unit of Boeing), Pipistrel Vertical Solutions, Karem Aircraft and Jaunt Air Mobility. And it has offered them guidance on VTOL specifications gleaned from its car ride sharing data: The craft should be able to travel between 20 and 60 miles per trip, at a speed of 150 miles per hour, with four passengers (and possibly a pilot). There are currently more than 100 aircraft makers worldwide designing VTOLs to Elevate's specifications, though, and they range from large corporations to small startups. "That's what's beautiful about this space. There's many different ways to reach the same end stage," Goel says.

"We're similarly working with the best battery cell providers in the world, to build packs that will ultimately go in an Uber Air aircraft," adds Elevate's Goel. One publicly announced partner in this realm is E-One Moli Energy Corp., based in Taiwan.

"The future of air travel is all electric. Some folks are starting with a hybridelectric approach, but everybody is aligned around the vision that these will be all-electric ultimately," he says. "The battery packs available today are of sufficient energy density to perform a large percentage" of Elevate's specifications, and that "continues improving at the rate of 5% to 7% year over year." One example of VTOL's coming evolution is the Bell Nexus, a prototype that was displayed at CES 2019.

"Nexus is really our solution to the vision of quick air travel with a connected in-flight experience, saving time and being efficient in the process," says Chad Stecker, Nexus program manager at Bell Flight in Fort Worth, TX. And in this context, "connected" means both onboard wireless access for passengers as well as V2X technology for full autonomy in the future — although initially the aircraft will have a pilot, Stecker explains. "We believe we'll have autonomous capability from day one," but the ability to activate it will depend on regulations and public acceptance of the technology, he says.

"We're working on hybrid-electric technology as well as all-electric," Stecker adds, noting that a hybrid scheme offers better range, at a speed of 150 miles per hour.

The hybrid system to be used in the initial Nexus vehicle uses a turbo generator that provides high-voltage power to the distributed propulsion system, which features six ducted fans that allow the Nexus to take off vertically and then transition to forward flight, similar to Bell's V22 tilt-rotor aircraft

By comparison, EmbraerX's eVTOL concept vehicle is a fixed-wing aircraft and all-electric today. It has eight rotors for hovering and two for forward cruising. It, too, is ready to be autonomous from the start, but "it's too early to give a precise date" when full autonomy will be introduced, because that's pending certification by regulators, Campello exclaims. Nonetheless, he estimates it could be coming before the end of the next decade, and sooner for cargo deliveries than for passenger flights.

V2X Connectivity for Self-driving Cars

VTOLs are just one piece of a future multimodal transportation ecosystem that is imagined to also encompass self-driving cars, many of which also could be electric vehicles (EVs). One key component of self-driving cars is V2X connectivity, or the ability for one vehicle to communicate with others and the infrastructure around it. According to the CTA study, Self-Driving Vehicles: Consumer Sentiments 2018, 62% of U.S. adults want to know more about how today's roads and other public infrastructure support both human-driven and self-driving cars together.

CTA also found almost two-thirds of consumers (60%) expressed interest in replacing their current car with a self-driving vehicle – signaling a strong market ahead.

Continental at CES featured a demonstration of V2X technologies under the theme "Mobility at your service. Freedom to Live." The showcase included the company's first Intelligent Intersection pilot — currently operational in Walnut Creek, CA — which combines sensors, software and DSRC (Dedicated Short Range Communication) at the intersection and sends information to the car about crosstraffic and pedestrians out of the line of sight; an Intelligent Street Lamps concept that enables sidewalk pole lamps that can sense available parking spaces, measure noise and air pollution, be remote controlled and updated with new software, and interact with the Intelligent Intersection tech to self-adapt to surrounding traffic; and a City Data as a Service (CDaaS) platform that brings together





Intelligent Intersection, Intelligent Street Lamp, automated shuttle, smart parking (which predicts and guides vehicles to available on-street parking spaces), in a portfolio of services that municipalities can manage and offer to visitors.

Another plan encompasses cloud-based vehicle remote control centers which can take over the vehicle when its own systems encounter a situation they can't handle.

Nissan also presented a version of this at CES. The automaker's Seamless Autonomous Mobility or SAM system combined artificial intelligence (AI) with V2X, prompting a self-driving car to safely stop and contact a human teleoperator, whom the automaker called a "mobility manager." As described by Nissan,

a self-driving car may be confused by a police officer using hand signals to direct it across double yellow lines and into the path of oncoming traffic. In this case, the mobility manager could access the vehicle's sensors (LIDAR, cameras and radars) to remotely assess the situation, send the vehicle a path to follow, and command the vehicle to continue in self-driving mode when the police officer gestures to go.

A new company named Designated Driver has a different take. The company's technology enables both the sort of "indirect" assistance described by Nissan and "direct" control, in which the teleoperator remotely drives the vehicle for a short distance himself.

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One of the smaller VTOL makers is Airspace Experience Technologies Inc., or ASX, a 12-person startup working from an airport hangar in Detroit.

Like Bell's Nexus. ASX's VTOL concept is hybrid-electric and connected and intelligent but can be produced at a far lower cost because it includes components sourced from the auto industry's EV ecosystem and is smaller in scale, says Jon Rimanelli, the company's founder and CEO.

"Transportation isn't just about cars, it's about platforms that move things," which can include scooters, bikes and mopeds, he says. However, "air mobility is a real opportunity because there are limitations to groundbased infrastructure and we've hit them. Very much like a skyscraper, you have to go vertical with transportation."

Rimanelli's ultimate objective is to move people five times faster than a car can, for the same price as driving, thereby connecting smaller suburbs with big cities and airports.

By between 2040 and 2050, Rimanelli says he expects half of all traffic to be airborne.

But Affordability Questions Persist

According to Uber Elevate's timeline, the first tests of unmanned VTOL aircrafts will take place in rural environments next year, followed by unmanned tests in urban areas, and then a full commercial launch of Uber Air in 2023 — in Los Angeles, Dallas-Ft. Worth, and Melbourne, Australia — using "skyports" atop buildings. At the company's Uber Elevate Summit last June, real estate developer Related Cos. was announced as an Uber Air partner and released a rendering of what a skyport may look like. It showed dedicated take-off and landing areas with enough separation

between them to accommodate simultaneous flight operations, plus infrastructure to charge as many as five eVTOL aircrafts simultaneously.

Plans notwithstanding, much besides regulations and aircraft certifications remain to be settled before any VTOL flies, not least of which is the cost of a ride, says Michael Blades, vice president of the aerospace, defense and security research team for the Americas at Frost & Sullivan, based in San Antonio, TX.

CTA Reports on the Future of Transportation

- Automotive Technology Roadmap: The Road to Autonomy Data Privacy: U.S., Europe and China Consumer Attitudes & Behaviors
- Self-Driving Vehicles: Consumer Sentiments 2018
- Economic Impact: Self-Driving Vehicles
- Understanding In-Vehicle Tech Use and Purchase
- Self-Driving Vehicles: Consumer Sentiments

For more information, visit CTA.tech/research.

"We're to the point now where we finally have the technology, especially from an electric vehicle standpoint, it's just not going to happen in a timeframe that Uber wants you to think," he says. "What's possible and what makes sense money-wise are two different things." Full autonomy is a long time coming, and "you're not going to get the cost down until you get the pilot out," he says.

"Congestion has been with us a couple of hundred years in cities, and for the longest time, especially since the car came along, people thought 'let's try to fly over the congestion,'" says Sam Schwartz, who in the 1980s was New York City's Traffic Commissioner and now heads an eponymous consulting firm that helps solve transportation and land use problems for municipalities small and large around the world. "Any futuristic book from 1930, -40, -50, -60 has had flying cars."

VTOLs are a "stupendous" idea, he agrees, but he's skeptical that the price point of a trip will ever fall low enough to be a mass-transit option. "I don't even see it widely used among the one-percenters," he says.

Even so, says Alexandre Marian, managing director of the automotive and industrial practice at the consulting firm AlixPartners in San Francisco, "the mobility players (like Uber have to find a way to expand beyond the ride sharing value chain," and this explains "moonshot projects" such as Uber Air.

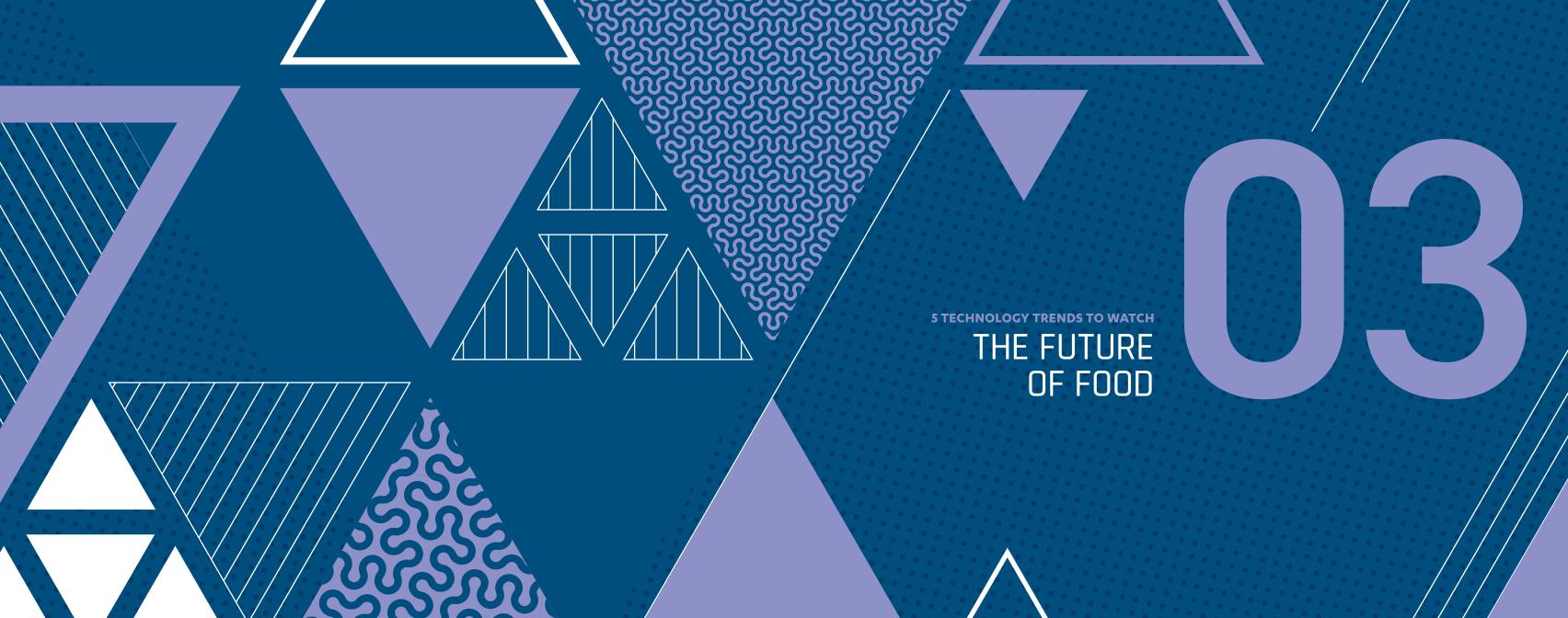
"We really don't know at this point whether the economics make sense," Marian says.



CES The CES Showroom: A Part-time Runway

One of the biggest stories from CES 2019 was the Bell Nexus Air Taxi, the helicopter company's massive hybrid-electric, self-driving aircraft meant to bring ridesharing to the skies. CES sessions on the future of mobility and flying taxis included executives from Bell, Uber Elevate, EmbraerX and Deloitte. CES 2020 will show how tech companies are revolutionizing everyday travel. Stay tuned as more aerospace and transportation companies announce their CES 2020 plans, including air carrier Delta.





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THE FUTURE OF FOOD

BY NATALIE HOPE MCDONALD

planting seeds in a similar way for years, tech improvements in vehicles, seeds, pesticides and irrigation are massively helping to feed the growing global

we are nowhere close to understanding the complex relationship between food

"Our fridges can tell us how long items have been in there and when we're running out. And if we have a food we don't know how to cook, we can ask Google, Alexa or Siri from the stove."

- Dr. Jonathan Deutsch, Drexel University

Deutsch says there are so many ways technology and food have become meshed, like "custom-designing food to our individual genetics and nutritional needs, being able to trace food in the marketplace to the individual farm and even the individual animal or plot where it came from."

And there are just as many factors that have contributed to why food tech is advancing so quickly, like the mainstreaming of smart appliances and business-to-business applications for farmers.

"Our fridges can tell us how long items have been in there and when we're running out," says Deutsch. "And if we have a food we don't know how to cook, we can ask Google, Alexa or Siri from the stove."

Beyond the consumer side, he says that the latest technology has gone a step further by improving supply chain and manufacturing so that we have consistently safe and tasty products.

Repurposing Garbage into Food

There are a few key areas where we see technology's most significant impact in terms of food development. Upcycling, for example, is helping to give new life to food that might have ended up in the trash.

Deutsch actually looked at how upcycling could save on waste and feed more people with a team of researchers at Drexel. "There is an economic, environmental and cultural argument for keeping food, when possible, as food and not trash," he explains. "Converting surplus food into value-added products will feed people, create opportunities for employment, entrepreneurship and lower the environment impact of wasted resources."



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It just requires a little imagination. For manufacturers, upcycling also offers new outlets for what used to be considered garbage. And for retailers, it's ushering in new categories of foods, such as a granola bar made from by-products of beer making, for example.

Philabundance, an anti-hunger organization in Philadelphia, has created its very own Rescue Relish, an anything-goes condiment that is made from items that don't get used in the pantry. It's the ultimate example of an upcycle success story. The result is a mix of tangy, sweet and sour flavors inspired by the Pennsylvania Dutch chow-chow recipe that they can't keep on the shelves. And the best part is it costs next to nothing to produce since it's created by food that would have been wasted.

The Impact of Urban Farming

Another way we're rethinking food is through peer-to-peer networks. It's estimated that there are about 500 million small-scale farmers operating around the world. Together, they grow almost threequarters of the world's food. Digital networks now allow these farmers to connect with each other and those within the supply chain — and with measurable results.

For example, a network like WeFarm allows farmers to connect in whatever language that they speak to discuss important agricultural topics related to everything from preventing crop disease and identifying insects to sourcing the most effective and affordable equipment for highly specific needs that can vary from region to region.

Another tool, Share the Meal, is a smartphone app that allows people to literally share a meal with someone within key hunger hot spots. Created by World Food Program USA (WFP) four years ago, the app

has inspired more than three million meals to be shared with Syrian refugees living in Jordan.

The potential of cell phone technology in this realm has also inspired the Bill and Melinda Gates Foundation to fund a wide range of new technologies to address productivity as it relates to environmental threats, water availability and other challenges. In fact, most discussions about food and hunger have also become forums on the environment. something that we can expect to become even more important in the next few years as more acute problems impact everything from temperature to weather patterns.



Share the Meal

The technological possibilities for addressing food-related questions is fairly open ended. While many of the inventions already consider hunger and productivity, still others are beginning to make key connections between the environment and food sustainability.

"While many people are focused on how to increase food production for a growing population," says Deutsch, "my hope is that technology helps

us become more efficient about storing, preserving and distributing that food so that hunger and food security can be eliminated. While it sounds like fantastical thinking, the mechanisms to achieve this goal exist. As the implications of climate change become more intensely felt, these efficiencies will be even more vital to provisioning the planet."

Urban farmers are addressing a few of these issues already, especially with the advent of vertical farming in well-populated areas that may be lacking in fresh, locally grown foods. Indoor and rooftop farming systems are designed to yield the most crops in the least space, while reducing issues like cost transportation to get food to people. In fact, most of the food being grown in urban environments today stays in the region, thus eliminating factors that can contribute to bigger carbon footprints overall.

Advancements in agricultural technology have also been yielding better, healthier crops, while helping to downsize the number of people needed for operations. New tools, like drones and GPS, can provide better overall monitoring of crops than people ever could. Using this new technology means that food can now be tracked from the farm right to someone's table, a feature that could become especially important as changes in the ecosystem have an even bigger impact on each facet of food growing, processing and delivery.

Meatless Meats and Edible Insects

Plant-based foods are becoming an inventive way to address sustainability as many of these new brands are essentially created in a lab. Plant-based alternatives to meat that actually taste like meat are starting to become a focal point of eco-friendly diets, an issue that promises to become important to potentially curb environmental dangers and solve problems created by cattle production.

By the Numbers

The Impossible Burger vs. Meat from Cows



Impossible Burger uses PERCENT LESS WATER



Impossible Burger uses 96 PERCENT LESS LAND



Impossible Burger saves **SQUARE FEET OF LAND**





PERCENT LESS GREENHOUSE

"The main message here is that we all need to eat less meat and find alternatives to our beloved animal proteins," says Deutsch.

"Meat analogues like these [Beyond Meat and Impossible Foods, for example] are a great way to do it. So are drawing from great vegetarian culinary traditions and entering them into the mainstream."

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Say Hello to Meatless Meat and the Maker of the Impossible Whopper

When the Impossible Whopper, a plant-based burger that tastes like actual beef, made its debut at Burger King this summer, the response was huge. It's virtually impossible to tell the difference between one of these burgers and the traditional Whopper the fast food giant has been serving up for decades. And people are noticing — one Burger King selling the sandwich in St. Louis outperformed the chain's national foot traffic average by 18.5%, according to CNBC.

5 Techs sat down with a spokesperson from Impossible Foods in Redwood City, CA, maker of the new meatless Whopper, to talk about how plant-based "meat" is made and why it could potentially address everything from dietary concerns and animal welfare to climate change.



What makes your Impossible products so appealing, even to carnivores?

Impossible Foods makes meat for meat lovers, without compromise in taste, nutrition or sustainability. We didn't make the Impossible Burger for people who eat a plant-based diet. In fact, the vast majority of people who eat the Impossible Burger are regular meat and dairy eaters. Only 3% of people who order the Impossible Burger say they've avoided animal-derived foods over the past three months. We believe that producing delicious, affordable and nutritious meats from plants can satisfy people's cravings and feed the growing world population while consuming far fewer of earth's natural resources.



How does this work exactly?

We take a molecular approach to understanding the full experience of eating meat. The Impossible Burger is the product of multiple years of research to recreate the entire experience and science

behind meat and how it tastes, cooks, sizzles and smells. Our scientists figured out the exact mechanisms by which meat flavor is generated from simple nutrients during cooking and discovered how to use these simple nutrients to recreate meat flavor just as it happens in meat from animals.



But how do you do this without using animals?

Our key ingredient, heme, is what gives the Impossible Burger its unique meaty flavor. In a recent test, the Impossible Burger ran even with conventional ground beef; about half the tasters (all meat-loving omnivores, no vegetarians or vegans) said they preferred the Impossible Burger over the ground beef burger, without knowing what it was or whether it was different from the burger from cows.



How is plant-based eating environmentally friendly?

With the launch of the new Impossible Burger recipe in January 2019, we worked with Quantis to carry out an updated life cycle assessment (LCA) to understand the sources of our own environmental impact — and rigorously compare it to the environmental impact of ground beef from cows. The impacts of an Impossible Burger are vastly lower: 87% less water use, 96% less land use, 89% fewer GHG emissions and 92% less dead zone - creating nutrient pollution than ground beef from cows. From a consumer perspective, this means that when they choose an Impossible Burger over a conventional beef burger, they save the greenhouse gases of the average American's drive to work, 73 square feet of land for nature and 170 water bottles worth of fresh water.



Another way to address environmental concerns is by using more sustainable sources of animal protein, like insects. Don't laugh, because the insect protein market could be worth \$8 billion by 2030, according to Business Insider. Many restaurants and grocers are already serving edible bugs, like Mom's Organic Market, a chain in the northeast that has an entire section in each store devoted to crickets and other insects in bulk.

"There is no panacea and preferred solutions may differ individually," says Deutsch, "but moving meat from the center of the plate and eating less meat, better meat or no meat is a shared priority for a more sustainable food system."

The trend is catching on worldwide. In Europe, a well-known meat company has gone completely vegan. Vivera Foodgroup in the Netherlands has become one of the first-ever meat companies to replace its animal products with all vegan foods. The CEO, Willem van Weede, "More consumers are discovering that plant-based products can be just as tasty as real meat and have many benefits for personal health, environmental impact and animal welfare."

- Vivera Foodgroup CEO Willem van Weede

says that the decision was based, in part, on the appeal of meatless foods and the sustainability in offers.

"More consumers are discovering that plant-based products can be just as tasty as real meat and have many benefits for personal health, environmental impact and animal welfare," explains van Weede.

Not for nothing, the alternative meat industry is expected to become a \$140 billion industry by 2029, according to Barclays. In fact, animalfree food could capture as much as 10% of the global meat industry by

Other companies jumping on the plant-based burger bandwagon include Nestle, ground beef producer Jensen Meat Company (they bought Before the Butcher, a vegan meat startup) and rap mogul Jay-Z's Marcy Venture Partners, which is also investing in new meat alternatives.

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How IoT is Ending Hunger

Hunger is a massive impetus toward creating food tech partnerships worldwide, and for very good reason. An estimated two billion people in the world lack vital nutrition, according to Project Healthy Children (PHC), an organization in Tanzania that scales tech and business solutions to help feed people in the most food insecure parts of the world. One of the organization's tech partners, Vodafone in the U.K., has provided cellular-enabled technology to help monitor flour mills in real time. The end results mean that more food is being produced efficiently for the people who need it the most.

Here's how it works: Vodafone supplies the technology to get the mills online and the mills can produce more and better product faster. PHC and Vodafone have essentially created a first-of-its-kind technology that enables small African flour mills in rural areas to fortify flour with key nutrients during the milling process in a way that is both sustainable and cost-effective.

It's been so successful that Vodafone's global IoT SIM and USB Connect technology, says Ludovico Fassati, head of IoT for Vodafone Americas in New York City, will be bringing real-time, data-driven insights to 3,000 more small-scale flour mills over the next four years.

To put this into perspective, consider that in the recent past, the same process required at least one worker to monitor 25 mills, which would fortify flour to feed about 125,000 people. "Vodafone's IoT SIM now connects the same worker to 100 mills, which will fortify flour for 500,000 people," explains Fassati. "The worker receives alerts remotely and in real-time when the mills run out of fortified flour or require maintenance."

This is an ongoing process, of course, based on a lot of trial and error in regions where technology is often lacking. But in the near future, Vodafone and PHC plan to roll out a global IoT SIM and USB Connect technology to local flour mills in both Tanzania and Rwanda, two areas hard hit by hunger, and will continue to implement the technology

Farms and Tech 2017 2019 SOURCE: THE FARM COMPUTER USAGE AND OWNERSHIP USDA REPORT 48% 49% 24% 24% 19% 19% With internet access laptops for business Purchase agricultural inputs over internet activities over internet accivities over internet non-agricultural websites

On the Mooove: Digital Wearables for Livestock

The market for animal tech is expected to grow to about \$2.5 billion in 2025, according to *Sensors* magazine. As more agricultural trends veer toward the high tech (think tractors with GPS, robotic milking and drones that lay seeds) finding new ways to monitor and protect animals is a big part of the equation.

Here are four important products that are changing the way animals are raised and treated:

1. E-TAGS CAN NOW HELP MONITOR AN ANIMAL'S BODY TEMPERATURE AND OTHER VITALS. Not only do these devices help farmers treat ailing animals early, they can help stop the spread of disease for roughly \$10 per cow.



- 2. E-COLLARS HELP MONITOR WHERE AND WHAT AN ANIMAL IS DOING ON ANY GIVEN DAY. Think of it as a Fitbit for cows. Not only does this data ensure that an animal is exercised and fed properly, it helps control the farm itself (like opening a gate to allow an animal to pass through).
- 3. CATTLE ARE OFTEN TAGGED TO ESTABLISH VITAL INFORMATION ON EACH ANIMAL. But new digital tags are providing even more options thanks to Bluetooth technology. These new electronic tags can now be scanned to provide details about where an animal came from, who owns it and how much it weighs. The tags also act like GPS trackers that can help scan multiple animals and showcase any movement between fields and owners.

4. COWBELLS HAVE EVEN BEEN UPGRADED.

The new electronic versions can signal when an animal is in danger by lighting up or alerting owners about impending problems. In fact, the new digital devices are believed to be better for an animal's health by not creating unwanted noise that can annoy or startle the beast. They also provide GPS tracking and create invisible fences.

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across Eastern and Southern Africa. They aim to have 3,000 of these bases operational in Tanzania by 2021, reaching roughly 20 million people. It has seven units currently running in Rwanda, servicing the most at-risk refugee population.

What makes this technology so important in addressing issues of food security worldwide is how it's ultimately making food more readily available in newer, smarter ways. Two billion people around the world are affected by micronutrient malnutrition, meaning they don't get the proper vitamins and minerals from their food supply. This causes high rates of disease, especially in children, such as birth defects, child development issues and blindness.

"The partnership represents our vision to transform lives by connecting every machine," says Fassati. "With Vodafone technology, PHC is taking a major step in ending micronutrient malnutrition." In fact, the partners expect to reach more than 100 million people worldwide with this food tech solution by 2025.

"3D food printing is only a method for food shaping and not modifying food ingredients. It has nothing to do with artificial food; the ingredients are the same as in conventional food products, only the flowability has to be adopted to the needs of the 3D printing process."

- Print2Taste

The Next Frontier: 3D-Printed Food

In the same way that technology is being used in precision agriculture and to address worldwide hunger, it's also being adopted to printing. In fact, the next frontier of 3D printing, as evidenced at CES, is shaped by everything from 3D-printed fashions to fake fingernails. Even more gamechanging is the evolving category of 3D-printed food.

Japan's Open Meals is just one of many startups that has created 3D printed sushi, which attempts to emulate the appearance, texture and taste of the real cuisine, but instead of coming from the ocean, it comes from a printer. Open Meals uses the Pixel Food Printer, a 3D printer that prints small cubes in the shape of food using edible gel. The printer actually injects each pixel with different flavors, colors and nutrients that are eventually combined and can be customized based on someone's nutritional needs.

What makes the potential for this development so influential is that the company's Food Base database is the first in the world in which food data is essentially collected and stored for download. Think of it as the iTunes of food — an online menu where you can pick what you want

for dinner, 3D print it and enjoy. Participating chefs can literally scan and send their own creations to the database where users can download and print the food anywhere there's a 3D printer.

Further, using DNA sampling, OpenMeals wants to be able to learn more about diners even before they walk into a restaurant. To do this, the company uses a health test kit that collects medical samples like saliva that is submitted and analyzed. The results can help determine the dietary needs of a customer so that when they visit a participating restaurant, they can literally customize their 3D-printed meals, thus opening up new

frontiers in the way food can be customized to meet very specific needs shaped by illness, vegetarian preferences and gluten-free restrictions.

The introduction of new 3D printers that specialize in food, though a niche industry, is growing. Print2Taste in Germany, for example, makes a popular 3D printing system called Procusini that allows users to print food and designs associated with food, like logos in chocolate. Its audience is expanding, though it's already found its own popularity within restaurant and catering industries worldwide.

According to a spokesperson for Print2Taste, maker of Procusini, "Nearly all kind of food products may be 3D printed." Popular trends tend to focus on bakery and meat products, as well as dairy products, pasta and confectionaries like jelly, marzipan, fudge or chocolate.

"For high-class restaurants and caterers (or pastry shops)," says Print2Taste, "the 3D food printer will simplify the production of creative personalized 3D objects, like logos, chocolate labels for desserts or cake, as well as creative pasta objects."

Company CEO Gerd Funk predicts that in the future we will see a 3D food printer in every kitchen producing food that's ultimately personalized to individual physiological needs and preferences.

Of course, a big misconception about printing food that will need to be overcome is that it's somehow artificial. "3D food printing is only a method for food shaping and not modifying food ingredients," explains Print2Taste. "It has nothing to do with artificial food; the ingredients are the same as in conventional food products, only the flowability has to be adopted to the needs of the 3D printing process."



The Future of Food at CES

Farming and food-related companies are relatively new to CES, but last year's show revealed a marketplace hungry for innovation. John Deere exhibited at CES 2019, showing a 20-ton smart tractor — the first combine at the show — alongside other company work in edge computing, machine learning and sensor fusion. Impossible Foods was another breakout star giving out free samples of its plant-based burgers from a food truck outside the Las Vegas Convention Center. CES 2020 will again showcase advances in food, agriculture and urban farming in this budding market.



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FACIAL RECOGNITION: POISED TO TRANSFORM OUR WORLD

BY JEREMY SNOW

f you've ever used Snapchat face filters to turn your photo into a dog or make a face swap with someone, you've used facial recognition technology. The viral technology can detect your face and specific features to apply humorous and sharable effects like making you look older, adding a crown of flowers to your head or a rainbow coming out of your mouth.

While seemingly minor, Snapchat's face filters are one of the most mainstream — and simplistic — uses of facial recognition, and while Snapchat has highlighted the tech's entertainment value, other companies have imagined more serious applications that have serious profit behind them.

Facial recognition technology is one of the most popular and novel developments in biometric technology, a field that focuses on using body measurements and calculations like fingerprints or iris scans for identification and security purposes. While Snapchat doesn't store data about your face – nor can it specifically identify who you are — other companies are taking the initiative.

Thanks to recent improvements in artificial intelligence (AI), computers have gotten much better at identifying and analyzing images and, in turn, faces. In the past few years, a plethora of facial recognition software and camera companies have worked to find more applications for the trending technology and employ it around the world. Facial recognition is being used for everything from security uses such as unlocking your phone or identifying criminals to medical applications such as helping Alzheimer patients identify their loved ones.

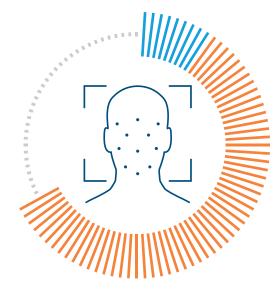
Its popularity has also led to a boom for it financially. The global facial recognition market is expected to grow from \$3.2 billion in 2019 to \$7 billion by 2024 — a 16.6% compound annual growth rate, according to a MarketsandMarkets research report. North America is expected to hold the largest market size during the five-year forecast, thanks to its high number of early adopters.

"The major forces driving this market are growth in surveillance, increase in government deployment and increase in the use of applications in numerous industry sectors," according to the report. "Growing demand for fast and secure user identification and regulatory compliances in the health care sector to handle patient information with utmost privacy and care would provide opportunities for vendors in the facial recognition market."

But to acknowledge the positive possibilities and growth of facial recognition market means one must also acknowledge the controversies behind its accuracy and role in increasing surveillance. Facial recognition is still a very young technology, and no matter how exciting it is, there are serious concerns about its accuracy and the inability to opt out of its usage in public. Plus, many researchers have noted the technology's

OF SURVEYORS
said they are aware of facial
recognition technology
(+1% change from 2015 to 2017)

9% OF SURVEYORS
who have used biometric
technologies have used
facial recognition technology



SOURCE: BIOMETRIC TECHNOLOGIES UPDATE, UNDERSTANDING CONSUMER SENTIMENTS, CTA

accuracy flaws could harm marginalized communities and minorities the most. But controversy is not new to the tech industry, which has long thought through the best way to incorporate contentious tech for the better of the world.



"Facial recognition is a tool, and like every tool or technology — from the hammer to the internet — it has good and helpful uses as well as bad and dangerous ones," CTA President and CEO Gary Shapiro said in a San Francisco Chronicle op-ed.

As facial recognition continues to grow, the tech world must ask an important question: How can we encourage facial recognition technology to grow and innovate without invading the privacy of the Americans it could help? Some tech groups have put their foot down, calling for an all-out ban of the technology.

But pulling the technology out at the root will only ensure nothing good could grow while the rest of the world continues to learn from it. CTA hopes to encourage the industry to continue to develop facial

technology, while aware of its challenges, to ensure the world can take advantage of its positive uses without having the technology break any constitutional rights. Instead of banning, we need balance.

"We shouldn't outlaw such innovations simply because they can be abused," Shapiro wrote. "Instead, we should carefully weigh the potential harms and benefits of different applications," he said. "If, in a specific instance, the possible harm outweighs the potential benefits, we can create narrow restrictions that will alleviate the harms but retain the benefits."

What's in a Faceprint

Facial recognition isn't sci-fi magic. It's a combination of advancements in data analysis, image recognition and artificial intelligence improvements and its strength lies in more than just "recognizing" a face. But currently, it is nearly impossible for any system to be 100% correct all of the time.

The first part of facial recognition software is the actual identification. You or anyone else's face is captured via photo or video, where the facial recognition algorithms read the geometry of your face, focusing on certain aspects to differentiate each face. Each system uses a different group of hyper-specific, measurable "facial landmarks" that make your face *your* own, such as the distance between your eyes, the space from your forehead to chin, nose width, cheekbone shape, jawline length and many more measurements. This information makes up your "faceprint."

The system then compares your face against the millions of other faces it has in its database to present possible matches based on a percentage. These databases rarely give a single 100% sure answer, and instead show

users a variety of possible faces that match closely with who is being analyzed. With the same technology, many systems can also recognize the emotions of your face as well and tell a database if you are happy based on your smile or angry based on your frown.

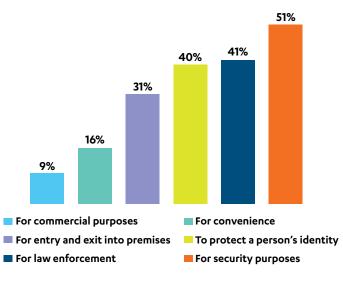
"Where you see a face, recognition technology sees data. That data can be stored and accessed," a Norton security blogpost wrote.

But there's a huge problem facing the current generation of facial recognition technology — it's prone to error, according to multiple sources and studies. No system is perfect yet, meaning relying on it as your main source of data or for serious issues such as implicating people in crimes is not reliable. Minor details such as the lighting, angle of the face or even the hat a person is wearing can drastically affect a computer's ability to accurately predict a face. For example, in July, the American Civil Liberties Union (ACLU) used Amazon's Rekognition technology on 28 members of Congress. The software misidentified all of them as people who have been arrested for a crime.

These inaccuracies also effect people of color and women at a higher rate, according to multiple studies, including the ACLU's report. "The false matches were disproportionately of people of color, including six members of the Congressional Black Caucus, among them civil rights legend Rep. John Lewis (D-Ga.)," the ACLU wrote.

According to the M.I.T. Media Lab, in the three leading facial recognition systems (Microsoft, IBM and Megvii) errors occur in nearly 35% of images for darker skinned women. The errors can be attributed to the data bias used to teach the AI software, typically composed of the faces of white men, making it harder to accurately predict women or other races.

Preference for Suitable Uses for Facial Technology



SOURCE: BIOMETRIC TECHNOLOGIES UPDATE, UNDERSTANDING CONSUMER SENTIMENTS, CTA

The industry has recognized this as an issue and is now turning to transparency to address harmful biases, with both Microsoft and IBM telling the New York Times it has already improved its algorithm. Companies recognize the need to quickly develop fair facial recognition, which has led to the creation of groups like Microsoft's Fairness, Accountability, Transparency, and Ethics in Al, or a similar accountability program from the Institute of Electrical and Electronics Engineers.

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Major Players in Facial Recognition

A Sample of Companies Tranforming Facial Recognition Software

Amazon Rekognition



CyberLink's FaceMe



Facebook DeepFace



FaceFirst



Kairos



Megvii



Microsoft Azure Face API



Sensetime



Private groups like the Algorithmic Justice League, started by Joy Buolamwini — the researcher behind the M.I.T. Media Lab report — are also leading the charge. To ensure a fairer future, Buolamwini recommends auditing existing software, building more inclusive data sets and ensuring the teams behind these programs are diverse and capable of "checking each other's blind spots," she said in her TED Talk on algorithmic bias.

"We've used tools of computational creation to unlock immense wealth," Buolamwini said. "We now have the opportunity to unlock even greater equality if we make social change a priority and not an afterthought."

From your Phone to the Store

You have most likely used facial recognition technology if you have uploaded a picture to Facebook. With the help of an optional tool, Facebook's software will recognize the faces in your pictures if they are your friends, making it easy to tag them. In 2017, it also released a feature to find photos you are not tagged in and detect people using your image as their profile picture.

Another mainstream use of facial recognition comes from Apple. Face ID, released in 2017 for the iPhone X and iPad Pro, allows users to unlock their phones by just looking at it. These tools are a good example of how existing companies are creatively using facial recognition to make already-existing products more user-friendly and approachable. It's also why many big computing and tech companies like Amazon and Microsoft have invested so much in developing their own recognition software.

Beyond improving user experiences, facial recognition can also offer serious benefits for certain groups. Fourteen-year old Emma Yang saw potential in facial recognition to help her grandmother who was diagnosed with Alzheimer's Disease. Her app, Timeless, "allows patients to use the phone's camera to identify the person standing in front of them," according to the Indiegogo page. With help from the technology, patients can stay better engaged and connected to their loved ones.

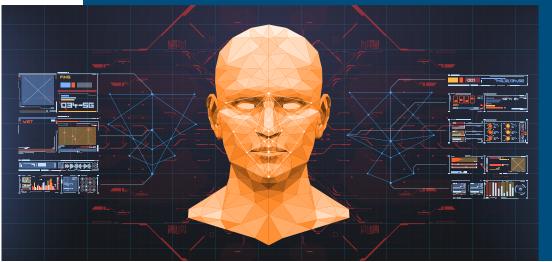
A research group took a similar approach to help those with autism. The Texas State High-Performance Engineering Research Group created a mobile app to help

Banworthy? The Policy Behind Facial Recognition Software

There's no denying facial recognition is a controversial and complicated topic. But in response to this developing technology, politicians have tipped the scales too far against innovation by pushing for constricting regulations that could stop it from ever finding its footing.

Already, there is a push for a complete or partial ban on the technology. San Francisco is the first city to ban the use of facial recognition surveillance technology, save for federally regulated places such as the airport. And 2020 democratic presidential candidate Bernie Sanders also called for a ban on facial recognition for police.

CTA is sympathetic to the concerns of researchers and activists, but also stands for the innovation, safety and jobs facial recognition technology will provide.



"There's no denying that facial recognition technology is not yet perfect. Innovators are working to fix bias in the algorithms, so the technology works for everyone, and security experts are working to keep our information secure. But we cannot afford to throw out or delay facial recognition technology, especially in the high-risk environments of airports. Our air safety and national security are at stake."

- Gary Shapiro, CTA President and CEO

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children on the autism spectrum recognize facial expressions through "quick and easy access to speech-language therapy using telepractice," according to the university's student newspaper.

Researchers see other medical uses for facial recognition, as well. Face2Gene, an app currently in testing, uses facial recognition to confirm diagnoses of genetic disorders where tiny, individual changes can make a big difference. Similar software is also being explored in dermatology, with object recognition technology helping doctors diagnose skin cancer. Many doctors see facial recognition as the future of instantaneous examinations, capable of "accurately [predicting] your health based on the shape of your face," according to Medical News Today. With just a selfie, a facial recognition program could predict your body mass index, blood pressure and general health.

Percentage of Those Comfortable with Allowing Facial Pattern Recognition to Inform Advertisers of Response of Commercials



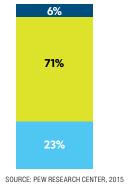
Comfortable with allowing facial pattern recognition to inform advertisers of my response to commercials

SOURCE: BIOMETRIC TECHNOLOGIES UPDATE, UNDERSTANDING CONSUMER SENTIMENTS, CTA

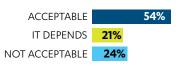
And in hospitals, medical researchers are beginning to imagine how it might revolutionize patient information and data, creating a world where a doctor can scan your face and figure out your medical history and information from previous visits. Some tech leaders even imagine hospitals that can detect your emotions to figure out if you need more attention or help with pain.

Facial recognition is also taking the retail world by storm, as companies see potential to help with marketing and customer analysis. Retail stores' uses are wide, from using it to stop shoplifters to measuring a customer's emotional reaction to items or ads. It could also be used for targeted assistance in stores, making it easier to integrate loyalty programs or point systems. Walmart has already tested the technology in its store, while Lowe's has begun using it.





Percentage of Workers Accepting Facial Recognition to identify thieves at the Workplace



Facial Recognition and Privacy: A Matter of Trust

While facial recognition will continue to be used for medical cases and to improve user experience, companies and the government are embracing its other major use: security. While this new technology can provide enhanced security wherever you go — including being able to track or identify criminals — it raises serious questions about privacy in a digital world. Since this technology is still young and developing, now is the time to discuss how we can balance security with privacy.

Already, the world has seen harmful uses of facial recognition, especially in China, where security cameras with such software are the norm, allowing the government to easily track its citizens and impede on their human rights. In Hong Kong, protestors and activists must wear masks and cut down facial recognition camera towers to avoid being recognized, tracked and arrested by police. Even in America, there is already worry that facial software companies' work with police is building the foundation of a database you'll be unable to hide from.

Just as companies have begun to discuss algorithmic biases in this technology, they have also discussed its role in surveillance and policing. Finding a balance between extra security and lost privacy is a question that both citizens and entrepreneurs will need to address. To do so, many are focused on staying as transparent as possible, explaining its data privacy programs and guidelines on their website. Many also have separate company groups focused on ethics and accountability within Al.

"While AI holds the promise of delivering valuable insights and knowledge across a multitude of applications, broad adoption of AI systems will rely heavily on the ability to trust their output," according to IBM's website

EVESCEN CONTROL CONTRO



Faces in the Crowd at CES

At CES see diverse uses of facial recognition, ranging from retail use to improved security for homes and businesses. CyberLink, a video editing software company, showcased FaceMe, its AI facial recognition engine which can identify a person's age, gender and emotions. Facial recognition is also used in SoftBank Robotics' Pepper robot, Byton's electric car and Procter & Gamble's prototype of a "smart store." And Tuya's AI video doorbell uses facial recognition to recognize if people should be allowed to enter your home.

on "Trusting AI." "To trust a decision made by an algorithm, we need to know that it is reliable and fair, that it can be accounted for, and that it will cause no harm."

"Moving forward, 'build for performance' will not suffice as an AI design paradigm," IBM continues. "We must learn how to build, evaluate and monitor for trust."

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ROBOTS REPORTING FOR DUTY

BY MARK CHISHOLM

obotics have long been on society's radar. To get the inevitable *Jetsons* references out of the way early, the generations raised on the vision of a future dominated by robotic maids and flying cars have grown into today's dreamers, innovators and consumers.

Parts of that vision have become reality, but not necessarily in the way they were depicted. Your robotic vacuum cleaner scoots around on your floor, but it doesn't quite resemble Rosie from *The Jetsons*. Another personal assistant rests in your pocket or a smart speaker. Different shapes, same functionality. Single purpose robots excel at their given tasks, but we're beginning to see robots that are intended to improve our well-being — companion robots that seek to combat isolation in the elderly, manage stress, or even educate children in STEM disciplines.

Robotic Caregiving

While robots have been prominent in popular culture for some time, the robots popping up recently differ in one significant way: They exist. Take for example PARO, a therapeutic robotic seal featured in an episode of Netflix's *Master of None*. This interactive robot, developed by the National Institute of Advanced Industrial Science and Technology in Japan (AIST), is intended to reduce patient stress in the elderly, including those suffering from dementia. PARO senses and reacts to touch, knows its name, and helps improve socialization between elderly patients and their caregivers. Also, he's adorable.

According to Johns Hopkins Medicine, roughly 12 million people in the U.S. require some form of home health care, a figure expected to climb as America's population grows older.

But PARO isn't the only companion robot on call, and the elderly aren't the only target demographic. Norway-based No Isolation was founded in 2015 with the mission of reducing loneliness and social isolation in children suffering from long-term illnesses. The company developed AV1, a telepresence robot that can take the child's place in the classroom, giving them the ability to see, hear and talk to their classmates and teachers remotely. The audio and video captured by AV1 is transmitted to an accompanying app. Through the app, children can control the robot's "head" in order to look around the classroom. They can also signal that they would like to ask a question and the robot will "raise its hand," so to speak, by flashing a white light on its head.



SOURCE: CTA, ROBOTICS: CURRENT LANDSCAPE & CONSUMER PERCEPTIONS



Companion robots were all over CES 2019. Pria, a home care companion robot from Stanley Black & Decker that was unveiled at the show, reminds users to take their medication, and even dispenses

the medication (up to 28 doses). Pria features a built-in camera for video check-ins with family or caregivers

as well as a digital assistant. These types of features enable an aging demographic to "age in place" rather than move to a facility where health care and companionship are typically provided, so the addition of companionship capabilities is welcome in this area.

Another example is BUDDY the Emotional Robot, developed by Blue Frog Robots, a mobile robot with a range of emotions. Not only does BUDDY allow users to make video calls via his video screen "face," but he can navigate the home, interact with users via human detection, recognition and tracking, and even display emotions based on

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users' interactions with him. Ignore BUDDY too long, and he'll make his displeasure known on his face. Beyond his interactions with humans, BUDDY can interface with connected devices in the smart home, detect motion and record video for home security purposes, and even help children to learn.

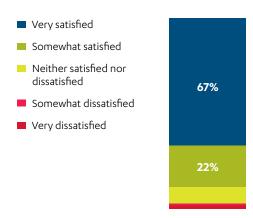
Samsung showcased the Samsung Bot Care at CES 2019. The robot combines Samsung's AI platform, Bixby, with sleek hardware. The Bot Care moves freely around an owner's home, and can offer at-home medical support, monitor prescriptions and read individuals' vital signs such as heart rate.

The global market size for health care assistive robots sits at \$430 million in 2019, according to the recent study, Robotics: Current Landscape & Consumer Perceptions. However, Global Market Insights forecasts that number to reach \$1.2 billion by 2024. While the potential for robots in caregiving and education is high, there are still barriers to widespread adoption. While older Americans create some of the best opportunities for caregiving robots, CTA's study found that nearly half of respondents (45%) aged 65 or older harbor negative associations with robots.

Overall, 67% of respondents are open to using robotics for health care applications, citing the cost effectiveness and time-saving potential of this technology. The main concern among this demographic involves doubts that robots can perform tasks safely and effectively. However, these concerns should abate as younger generations age — the study found that millennials and young gen-xers (aged 35 to 44) are the most open to robotics.

China is one country where robotic caregiving is on the rise. There are currently more than 240 million people aged 60 years or older in China, and that number is expected to reach 400 million by 2033. The

Level of Satisfaction with Health Care Robots

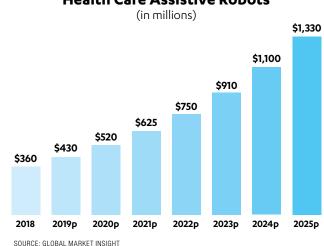


SOURCE: CTA. ROBOTICS: CURRENT LANDSCAPE & CONSUMER PERCEPTIONS

CTA study includes a case study on iPal, manufactured by Nanjing-based AvatarMind. The humanoid robot, demonstrated at CES, is responsive to speech and touch and can hold conversations. iPal can give weather reports, remind users to take their medications, and send live video feeds of its users to family members.

The aging demographic across the globe creates opportunities for technology firms, but challenges remain. Increasing awareness and acceptance of robotics across the board — but particularly with older adults — is vital to the success of caregiving robots.

Estimated Global Market Size Growth for Health Care Assistive Robots



CTA Foundation and Robotics

The CTA Foundation is a public, national foundation established with the mission to link seniors and people with disabilities with technologies that enhance their lives. The Foundation is focused on strategic support of programs to impact these communities and has provided more than \$3.2 million in grants and over \$3.9 million in total funding to support these populations. Working on behalf of the consumer technology industry, the CTA Foundation uses technology to empower people to stay socially connected and live healthy and independent lives.

The CTA Foundation has worked with a number of companies related to robotics, including:

A&K Robotics

A&K ROBOTICS

Intuition Robotics ElliQ

intuition robotics

Joy for All

Joy for All

Linkdyn Robotics

ID LINKDYN

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Lord

OHMNILABS

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Softbank Robotics' Pepper

Suitable Technologies Beam

PARO

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Robotic Educators

While we may still be a ways from robots teaching at the front of the classroom, robots are nonetheless making their presence felt in the educational sector. Robots are serving as teaching assistants, enabling remote participation via telepresence (see the aforementioned AV1 robot), and promoting STEM learning outside the classroom.

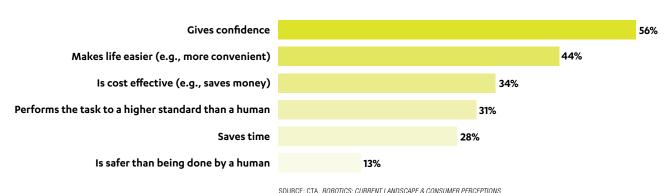
In CTA's Robotics: Current Landscape & Consumer Perceptions study, respondents reported extremely high awareness (81%) and interest in educational and STEM robots. Consumers also reported near universal openness (92%) to using robotics for education applications ranging from gamified problem solving for children to programming and STEM lessons for older users. This follows similar acceptance of technology's role in education.

In CTA's Tech in Education: Parents and Educator Use and Sentiment report, educators (87%) and parents (91%) both agreed that "technology allows students anytime/anywhere access to education." The study found that seven-in-ten (71%) of educators and two-in-three (67%) parents indicated that STEM-specific products are "important" in encouraging student learning and education. However, only 11% of respondents in CTA's robotics study indicated that they had personally interacted with a STEM robot.

These products and tools can take a number of forms. AT CES 2018, BinaryBots brought their build-it-yourself robots to Eureka Park, where they spoke to CTA's *It Is Innovation (i3)* magazine. Children build BinaryBots robots using kits that include cardboard and plastic components, and circuit boards that feature a speaker, light sensor,

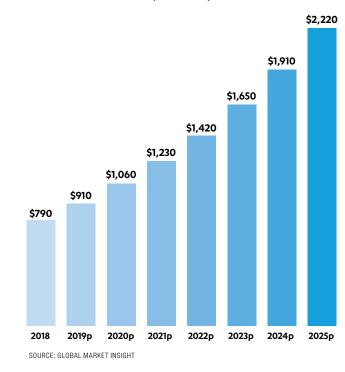
Perceived Benefits of Using Education / STEM Robots

(Among those open to using education / STEM robots)



Estimated Global Market Size Growth for Educational Robots

(in millions)



programmable LEDs and two touch sensors. The kits also include a pocket-sized computer kids can code: the BBC micro:bit. "We're trying to help every child from the age of five up learn not only how to code, but also about robotics and the Internet of Things," explained BinaryBot's Chris Burgess. Big names such as LEGO and Fisher-Price have also begun offering coding kits. The Erector Sets of today, robotics have massive potential in teaching STEM-related fields, thereby becoming their own biggest advocate.

A different type of STEM robot has made its way to the classroom floor. In China, a two-foot-tall robot named Keeko is now a robotic teaching assistant for kindergartners. The robot helps educate children by telling stories and

introducing problems to solve. The cute autonomous robot engages with the children, flashing heart-shaped eyes when the children answer a question correctly.

As of 2018, Keeko robots were in 600 preschools across the country.

Much like caregiving robots, Global Market Insights expects the future to be bright for educational and STEM robots, growing to \$1.91 billion in 2024, from \$910 million this year.

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Robots at Retail

SOURCE: GLOBAL MARKET INSIGHT

Another area robots are having a dramatic effect is on the retail show floor. Retail and hospitality robots have arrived, perhaps exemplified best by SoftBank's humanoid robot Pepper. This category of robots, along with delivery robots, represents the largest sectors for robotics, potentially because these are already prominent sectors in the economy, according to CTA's Robotics: Current Landscape & Consumer Perceptions.

Estimated Global Market Size Growth for Retail Robots

(in billions) \$20 2020p 2021p 2022p 2023p 2024p 2025p In Pepper's case, the robot acts as a greeter at more than 100 SoftBank Mobile locations in Japan. The four-foot-tall robot features a 10-inch display providing information for customers and can recognize human emotions. Outside of SoftBank Mobile, Pepper has been deployed in a number of roles, including as a hospital receptionist. Crossing over from the role of concierge, Pepper is also deployed in academic settings (to teach programming and study human-robot interaction), and in health care (caring for the elderly in a study from Middlesex University and the University of Bedfordshire).

As a sales "person," Pepper has shown promise. In a 2016 pilot at a Palo Alto tech shop (b8ta), the retail store claimed a 70% increase in traffic during the week Pepper worked there. A second pilot at a Santa Monica retail outlet claimed a 13% revenue increase. Shopper's curiosity about Pepper, along with its responsiveness and engagement, made for a memorable in-store experience.

Hardware retailer Lowe's has also experimented with robots. Lowes Innovation Labs worked with Fellow Robots to deploy a customized version of the NAVii autonomous retail service robot, dubbed the LoweBot, to answer customers' questions and process customer (and employee) requests. The LoweBot roams the retail floor, acting as a mobile information kiosk. This wasn't Lowe's first experiment with robots – the company had previously debuted the "OSHbot" in 2014.

At CES 2019, both LG and Samsung showcased their service robot offerings. LG unveiled a new line of LG CLOi service robots – the PorterBot, ServeBot and CartBot. These robots are "designed for environments such as airports, hotels, supermarkets and malls to assist customers, transport luggage, deliver meals and carry groceries," according to the company. Samsung debuted the Bot Retail alongside the previously mentioned Bot Care. This robot is intended to be used in either retail or service environments.

For their part, consumers have welcomed retail and hospitality robots. According to CTA's robotics study, among consumers who are open to using these types of robots, key perceived benefits include convenience (63%), saving time (58%) and cost effectiveness (53%). The market potential for retail robots, compared to other areas, is huge. According to Global Market Insights, the global market will reach \$60 billion by 2024, up from \$24 billion this year.

The Fleet of the Robotic Future

Robots are reporting for duty across a wide range of areas. From home robots and robotic vacuums, to caregiving robots, hospitality robots and more, an AI-powered fleet of assistive robots is reshaping tomorrow.



CES Robots at CES

Robotics is a consistent theme at CES. The future of robotics was omnipresent at CES 2019 with the latest in companion, health and customer service robotics on display from exhibitors including Honda, LG, Samsung, Sony, SoftBank, Toyota and Ubtech. Specifically, several exhibitors highlighted the capabilities of companion robots that will address the challenge of managing care and limiting social isolation for the elderly and individuals with limited mobility. This development is only made possible by recent advancements in machine learning, sensors, data connectivity and other underlying technologies.

Robotics, drones and artificial intelligence promise to be a major theme once again at CES 2020, taking place January 7-10, 2020, in Las Vegas, NV.





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