



# CB DIGEST FOR TECHNOLOGY

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Every week CB DIGEST scours many of newspapers, magazines, and websites, searching for the most intriguing tech stories and the most thoughtful things – left, right, and in-between. The CT DIGEST also reports on what the smartest people are saying about the world.

**CHAMBIZ** 

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## FDA approves compassionate use of anti-malaria drug chloroquine for the treatment of coronavirus



The anti-malaria has been used in France and other Asian countries. A recent study conducted by Thomas R. Broker, (Stanford PhD), James M. Todaro (Columbia MD), and Gregory J. Rigano, Esq., in consultation with Stanford University School of Medicine, UAB School of Medicine, and National Academy of Sciences researchers, shows that over the counter anti-malaria pills Chloroquine may be highly effective at treating coronavirus COVID-19.

Chloroquine and his sister drug, hydroxychloroquine, have been used

to treat malaria since World War II. Now, the Food and Drug Administration (FDA) has approved the 'compassionate use' of chloroquine to treat coronavirus patients in the United States. The idea behind the compassionate use is not new. It is a longstanding FDA program that allows for a physician to use an investigational drug in a patient under a protocol that undergoes review by an institutional review board and the FDA itself, while in addition enabling the agency to collect data.

The announcement came during the daily Coronavirus Task Force press briefing. The announcement came during the daily Coronavirus Task Force press briefing. Above is a video of U.S. President Trump making the announcement.

## 5G and MEC on the WING, as Nokia fuels carriers' global Industry 4.0 push

Nokia's IoT roaming service, WING, now includes support for 5G networking and edge computing, as the Finnish vendor seeks to help mobile operators drive industrial change in global markets. Its so-called Worldwide IoT Network Grid (WING) affords operators a way to offer cellular IoT services without having to invest in global infrastructure. The upgrade means they can also establish 5G-based IoT services, and attendant edge capabilities, in global markets.

WING offers a pay-as-you-go business model for global IoT infrastructure. Nokia said operators can get rolling with 5G-based IoT – affording low latency, high security, and go-faster throughput – “faster and [more] cost-effectively”.

At the same time, Nokia has established a 5G WING testbed in Dallas, in the US, for operators to test the full range of 5G IoT services, it said. They can connect with the facility remotely, as well as visit. The 5G NR standard is still evolving, noted Nokia, and the availability of a global platform for committable 5G operations means operators can start to attack brand new 'vertical' markets. Nokia cited connected cars, critical public services, real-time industrial monitoring and control, and remote healthcare, as primary opportunities.

## First US clinical human trial of potential coronavirus vaccine set to start Monday

The Wall Street Journal reported on the vaccine being developed by Moderna in February, which is a relatively young company built around this gene-based approach to drug therapy development. At the time, the paper reported that testing was set to begin in April, but it seems like the change in the situation globally between the end of

February and today has accelerated the timelines involved. That said, any final validation of a vaccine, even if it proves effective in trials, is at least a year to 18 months out, according to public health officials.

### **Amazon Pitches Its Cashierless Tech to Walmart, Target**

Amazon has courted major retailers like Walmart and Target to use its cashierless 'Go' technology in their stores, according to The Wall Street Journal. So far, neither retailer is biting. Amazon is planning to make some of its cashierless software open source, according to WSJ. The fact that Amazon is pitching retailers as large as Walmart and Target shows Amazon's ambitions to expand its cashierless tech beyond its own stores. (As we've reported, the company has faced challenges expanding its own Go store network across the country and is behind on internal goals.) It's no surprise that Walmart and Target are resistant to the idea of using Amazon's technology. Retailers should be wary of getting into business with Amazon, their fiercest competitor, as we reported last month.

### **MixComm Introduces 28 GHz Beamforming Front-End IC Based on Enhanced 45nm RF SOI Process**

MixComm, a New Jersey-based fabless semiconductor startup, has released its first 28 GHz Beamforming Front-End IC Based on an Enhanced 45nm RF SOI Process. The SUMMIT 2629 production device, integrates novel power amplifiers, low noise amplifiers, T/R switching, beam-formers, calibration, gain control, beam table memory, temperature and power telemetry, and high-speed SPI control for a front-end module with optimal partitioning for 5G infrastructure. The device is fabricated in GLOBALFOUNDRIES 45RFSOI which has inherent advantages over other semiconductor technologies for infrastructure applications. The SUMMIT 2629 operates from 26.5-29.5 GHz and is the first of a family of MixComm mmWave devices.

The company's technology is based upon breakthroughs developed at Columbia University CoSMIC Lab led by Dr. Harish Krishnaswamy.

### **Amazon is hiring 100,000 new full-time and part-time workers in U.S. to keep up with the demand**

With all the bad news about coronavirus pandemic, there is good news the mainstream media is not talking about. One of the good news is coming from e-commerce giant, Amazon. Today, Amazon announced it is hiring 100,000 new full-time and part-time 100,000 workers to keep up with online shopping surge caused by a surge in online shopping. The online giant said giant is adding 100,000 new distribution workers across the United States to keep up with the demand. The jobs will be Amazon's fulfillment centers and its delivery network.

### **Disney Seeks Buyer for Ad Tech Firm TrueX**

Disney is seeking to unload TrueX, an ad tech firm it absorbed as part of its \$71 billion acquisition of Fox assets. The firm builds technology that makes ads interactive—asking people to fill out a short survey for example before watching an ad, for example. The idea is to prove that users are engaged with an ad, therefor making the ad more valuable. Disney never really knew what to do with TrueX, and as we previously reported there'd been internal speculation since at least last summer that it was going to unload the property. As The Wall Street Journal story that broke the news explained, TrueX wasn't even integrated into Disney's ad team under Rita Ferro. TrueX essentially continued serving the customers it currently had as a somewhat independent entity within Disney.

Whether Disney can actually find a buyer for TrueX is another matter entirely. It's not exactly a boom time for ad tech deals, and that was before the coronavirus pandemic ground all business to a halt. It's possible that, absent any deal, Disney might just disband the group and finally integrate it into the sales structure, or just shut down the whole business entirely.

### **Trump Invokes Defense Production Act to Surge Industrial Capacity**

On Wednesday, March 18, 2020, President Trump issued an executive order invoking Section 101 of the Defense Production Act of 1950 in an effort to "surge capacity and capability to respond to the spread of COVID-19."

The DPA – a Korean War-era law – has been invoked dozens of times since its enactment in 1950 and provides the government with special authority during emergencies to control, prioritize and direct production and the provision

of services by commercial enterprises. Specifically, the DPA authorizes the president to require companies to enter into government contracts and fulfill purchase orders and to prioritize the production of materials and performance of services necessary for national defense. The DPA also allows the president to use loans and other incentives to increase production of essential products.

Historically used for military production purposes, this authority will be used presently to procure "personal protective equipment and ventilators," and "other health and medical resources needed to respond to the spread of COVID-19 within the United States."

### **Tesla to temporarily shut down Fremont factory**

Tesla will suspend production at its Fremont, Calif., factory beginning March 23, days after a shelter in place order went into effect in Alameda County due to the COVID-19 pandemic that sparked a public tussle between the automaker and local officials over what was considered an "essential" business. Some basic operations that would support Tesla's charging infrastructure and what it describes as its "vehicle and energy services operations" will continue at the factory, which under normal circumstances employs more than 10,000 people.

Tesla will also suspend operations at its factory in Buffalo, N.Y., except for "those parts and supplies necessary for service, infrastructure and critical supply chains," the company said in a statement.

### **Former Google and Uber Self-Driving Car Engineer Pleads Guilty to Trade Secret Theft**

Anthony Levandowski, a former star self-driving car engineer who worked at both Google and Uber, pleaded guilty on Thursday to a single count of "theft of a trade secret," according to a plea agreement viewed by The Information. His plea resolves 33 counts of trade secret theft filed by federal prosecutors last year against Levandowski.

The plea agreement follows years of civil and criminal legal battles relating to accusations that Levandowski took thousands of proprietary technical documents when he left Google in late 2015 to launch a startup developing self-driving technology. The startup was later acquired by Uber, which put Levandowski in charge of its self-driving car unit. The plea agreement between Levandowski and prosecutors involves a largely non-technical document related to three months worth of internal updates about what various teams within the Google unit, now an Alphabet subsidiary called Waymo, were working on in late 2015.

It doesn't relate to technical documents at the heart of Waymo's civil lawsuit against Uber, filed in 2017, that accused the ride-hailing company of hiring Levandowski with the intention of copying the designs of Waymo's spinning laser sensors for self-driving car prototypes.

Levandowski had been a key member of the team at Waymo that developed the sensors, also known as lidars. Uber fired Levandowski in 2017 after he didn't cooperate in the case, and afterwards Levandowski started a different company related to automated driving. Waymo settled its civil suit against Uber during a 2018 trial, with Uber giving Waymo stock in Uber that has since dropped in value.

The criminal plea comes several weeks after Levandowski filed for bankruptcy following a state court ruling that he had to pay Google \$179 million for launching a rival self-driving vehicle startup—the one that Uber acquired—and hiring staff from the Google self-driving car unit to join him. The bill owed by Levandowski was the same as the amount of money Google paid him for his contributions to the company over the years, plus legal fees and interest.

In pleading guilty, Levandowski acknowledged that he intended to convert the trade secret to the "economic benefit of anyone other than the owner thereof."

Levandowski faces a maximum penalty of 10 years in prison but prosecutors commonly ask for a lesser sentence when defendants plead guilty to lesser crimes. If Levandowski isn't sentenced to prison, it is likely he would resume

his role as CEO of Pronto AI, a company that develops semi-automated driving features for trucks, which he founded last year with several former colleagues. He stepped down when he was charged.

### **Sequoia Capital Plots \$7B Fundraise**

Venture fund Sequoia Capital is seeking to raise an additional \$7 billion across multiple funds to invest in startups in the U.S., India and China, according to Bloomberg.

With new funds in the works, Sequoia is making it clear it's open for business despite economic uncertainty caused by the global coronavirus outbreak. News of Sequoia's fundraising plans comes two weeks after it published a letter to its startups, in which it referred to the virus as a "black swan event" and warned companies about supply chain disruptions, drops in business activity and more.

While many startup leaders fear investors will refrain from making new investments as coronavirus rattles the economy, established funds like Sequoia, Andreessen Horowitz and Benchmark have shown they are able to raise money from their limited partners and continue deploying capital to startups, even in tough times.

After all, Sequoia has no shortage of capital. The Google and Airbnb investor pulled in \$1 billion for U.S. investments in December, as well as another \$2.4 billion for venture and growth deals in China, according to paperwork filed with the U.S. Securities and Exchange Commission. Additionally, the firm began investing out of a \$8 billion global growth fund in 2018 and as of January, had invested less than 20%, per The Wall Street Journal.

### **Starsky Robotics shutting down**

Starsky Robotics, a maker of driverless trucks, announced it is shuttering its doors, citing the unmet promise of AI in solving technical problems. The San Francisco-based startup had raised just over \$20 million in funding since it was founded in 2015.

### **Impossible Foods raises \$500M for faux meat**

Plant-based meat company Impossible Foods said it raised about \$500 million in a Series F round led by South Korea's Mirae Asset Global Investments. The fundraising brings total financing to date for the nine-year-old, Silicon Valley-based company to nearly \$1.2 billion.

### **Tempus secures \$100M for health AI**

Tempus, a healthtech company started by Groupon co-founder Eric Lefkowsky, has raised a \$100 million Series G round at a post-money valuation of \$5 billion. The money comes less than 10 months after the Chicago-based company raised a \$200 million Series F round at a pre-money valuation of \$2.9 billion.

### **Israel cybersecurity startup Axis Security emerges from stealth with \$17M Series A funding**

Axis Security, the private application access startup, today emerged from stealth with \$17 million in funding to launch a purpose-built, cloud-native security and analytics platform that offers organizations simple and secure control of private application access. Built on a zero-trust approach, the Axis Application Access Cloud offers a new agentless model that delivers the easiest and safest way to connect users on any device in minutes to private apps without touching the network or the applications. The initial investment came from Cyberstarts, a VC firm backed by founders and entrepreneurs from Sequoia Capital, Palo Alto Networks, Check Point, Imperva, among others. Ten Eleven Ventures' Alex Doll led the Series A round in which Cyberstarts was the first investor. Additional investors include Dan Amiga, founder of Fireglass, and board of director member Michael Fey, former president of Symantec and Blue Coat.

Founded by Dor Knafo and Gil Azrielant, the San Mateo, California-based Axis Security is a privately held, venture-backed company, headquartered in San Mateo, California, with research and development in Tel Aviv, Israel. The Axis Application Access Cloud solves the issue of implicitly open network access and removes the pain points of network-based security associated with Virtual Private Networks (VPN's). VPN's can be complex, slow to deploy, hard to manage and inflexible, especially when it comes to providing access to third-party supply chain partners, vendors, contractors, and remote employees.

### **Spectro Cloud launches with \$7.5M investment to help developers build Kubernetes clusters their way**

By now we know that Kubernetes is a wildly popular container management platform, but if you want to use it, you pretty much have to choose between having someone manage it for you or building it yourself. Spectro Cloud emerged from stealth today (March 17, 2020) with a \$7.5 million investment to give you a third choice that falls somewhere in the middle. The funding was led by Sierra Ventures with participation from Boldstart Ventures.

### **Gojek reportedly raises \$1.2B**

Indonesia-based ride-hailing provider Gojek has reportedly raised \$1.2 billion in fresh funding. The financing would bring total funding to around \$1.4 billion, with backing from Google, Visa and Tencent Holdings, among others.

### **One lands \$17M for digital banking**

One, a new neobank targeting the middle class, announced this morning it has raised \$17 million in Series A financing from Foundation Capital, Core Innovation Capital and Obvious Ventures. The company, based in San Francisco and Sacramento, is co-founded by former Intuit CEO and PayPal founding CEO Bill Harris and PushPoint co-founder Brian Hamilton.

### **Equinix closes \$355M Packet purchase**

Data center giant Equinix has completed its \$355 million purchase of New York-based Packet, a provider of

automated infrastructure for edge computing. Founded in 2014, Packet previously raised over \$36 million in venture funding.

### **HashiCorp raises \$175M at \$5.1B valuation**

San Francisco-based HashiCorp, announced it has raised \$175 million in a Series E financing led by Franklin Templeton Investments at a massive \$5.1 billion valuation. Founded in 2012, HashiCorp provides cloud infrastructure automation technology for operations, security, networking and application delivery.

### **E25Bio raises \$2M for Covid-19 test**

E25Bio, a developer of rapid diagnostic tests for dangerous infectious diseases, announced this morning that it has raised a \$2 million financing from Khosla Ventures. The 2-year-old Cambridge, Massachusetts startup is based out of The Engine, an MIT organization for founders tackling hard technology problems.

### **Fox buying Tubi for \$440M**

Fox Corporation announced it will acquire streaming startup Tubi for \$440 million in cash. Tubi, which is based in San Francisco, is an ad-supported streaming service with more than 20,000 titles from over 250 content partners.

### **Deepgram raises \$12M for enterprise speech recognition**

Deepgram, a startup focused on high-quality, real-time speech recognition, announced a \$12 million Series A this morning (March 18, 2020). The startup, founded a half decade ago, according to Crunchbase data, with just a few million in raised capital, is interesting, as its success to date was founded on two consecutive experiments. The first dealing with its technology, and the second concerning its market. Deepgram sits in the midst of our continuing conversation about AI-grounded companies, or at least companies that make use of deep learning.

Deepgram's \$12 million investment was led by [Wing VC](#). Other firms took part, including [Nvidia](#) as mentioned, and [Y Combinator](#) and [SAP](#).

### **Scopely adds \$200M to Series D**

Less than five months after raising a \$200 million Series D, mobile game publisher Scopely has closed on a \$200 million extension of that round. The financing gives the Culver City, California-based company a post-money valuation of \$1.9 billion.

### **UserTesting secures \$100M for feedback platform**

San Francisco-based UserTesting announced the closing of a \$100M funding round led by Insight Partners. The company is known for its Human Insight Platform, which lets businesses get feedback from customers on demand so that they can learn more about how to improve experiences.

### **Ada raises \$44M for customer chatbot**

Ada, a Toronto-based developer of an automated customer experience (ACX) platform, has raised \$44 million in a Series B round led by Accel. The company says it can train its chatbot to understand and address topics specific to a particular business, while getting up and running in weeks.

### **Airbnb mulls more private funding**

Airbnb is reportedly fielding funding offers from private investors amid the sharp slowdown in travel and hospitality spending. The company has seen interest from venture capitalists, private equity firms and sovereign wealth funds, according to sources.

### **E-learning platform Yuanfudao raising round at \$7.5B value**

Chinese online education platform Yuanfudao, which is backed by tech giant Tencent Holdings, is reportedly close to completing a financing round that would value it at around \$7.5 billion. Founded in 2012, the company offers online courses and homework plans to primary and secondary school students.

By Eugene Demaitre



*Sense Photonics was one of the few solid-state lidar vendors at MODEX 2020. Source: Sense Photonics*

Among the trends spotted around the MODEX supply chain show here last week was interest in widening automation applications beyond the interiors of warehouses and factories. But before robots can load and unload trucks or safely work alongside people in more dynamic environments, they need to see more clearly. Solid-state lidar is one way to do so.

Sense Photonics Inc. (*\* Chambiz DF 23 March 2019*) was among the exhibitors at MODEX 2020 and offered observations about solid-state lidar and logistics robotics.

Durham, N.C.-based Sense Photonics came out of stealth and released its Solid-State Flash LiDAR sensor last fall. The 3D time-of-flight camera is intended to provide long-range sensing, can distinguish intensity, and works in sunlight.

The ability to detect intensity is important when perceiving things like forks on a forklift truck, which are often black, reflective, and close to the plane of a floor. Forklifts are involved in 65,000 accidents and 85 fatalities per year, according to the Occupational Safety and Health Administration.

#### Developing better sensors for mobile robots

The founders of Sense Photonics previously worked together at a solar power company, where they learned the core processes for manufacturing semiconductors. That prior experience in photonics and silicon is applicable to designing laser emitters on a curved substrate for wider field of view.

“I’ve been at robotics companies for 10 years — I was at Omron Adept,” recalled Erin Bishop, director of business development at Sense Photonics. “I’ve used [Microsoft’s] Kinect cameras for unloading trucks, but all these robots need better 3D cameras.”

“Intel’s RealSense is good for prototypes and indoors, but there are a number of different attributes that matter a lot,” she told The Robot Report. “Robots are especially useful for dull, dirty, and dangerous jobs outdoors, and you need mounted or mobile cameras that can withstand exposure to the elements.”

Bishop noted the challenge of seeing multiple rows of pallets or lifts at 50m (164 ft.) indoors. “Forklift forks are usually caught in the noise from the floor,” she said. “In addition, humans eyes don’t see 2D representations of 3D data very well. The conversation is starting about 3D data output and training sets and labeling using RGB.”

One benefit of a custom emitter rather than Frequency Modulated Continuous Wave (FMCW) is that it avoids “sense crowding” at the 850nm wavelength, explained Bishop, who spoke at RoboBusiness 2019 and CES 2020. “We’re at 940nm, which works in sunlight and won’t interfere with other lidars,” she said.

“With high dynamic range or HDR, we get only 10% reflection in 100% sunlight,” she said. “We’re putting out a lot of photons, cutting through ambient light, and we can get a return from a dull black object like a tire or a mixed-case pallet and subframes.”

“By separating the laser from the receiver, it’s easier to integrate, and you have better EMI [electromagnetic interference] properties,” she claimed. “Sense One and Osprey offer indirect time-of-flight [ITOF] sensing.”



*A modular lidar architecture allows for separation of the emitter from the receiver for use in vehicles. Source: Sense Photonics*

### **From solid-state lidar to ‘cameras’**

“The technology is mature, but it’s not 100% versatile,” Bishop observed. “The whole lidar industry is moving from ‘sensors’ to ‘cameras’ — ‘lidar’ is a bad word, and robotics companies aren’t interested. They prefer ‘long-range 3D camera.’”

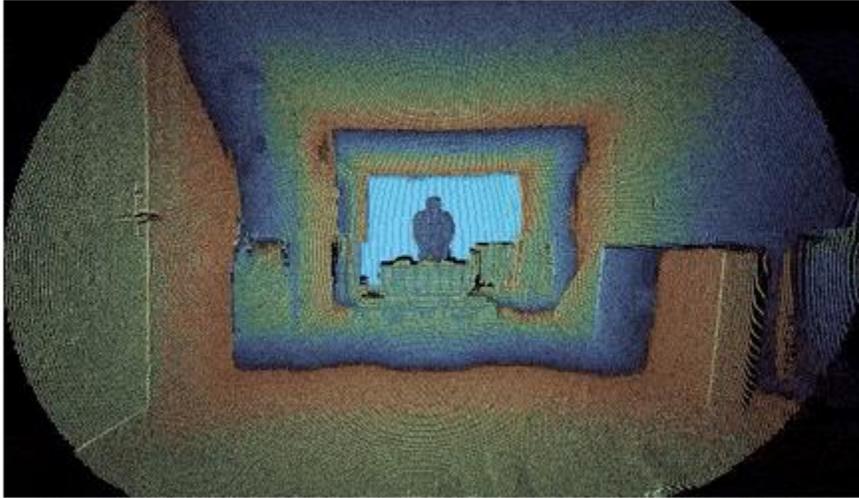
“The detector collects 100,000 pixels per frame on a CMS ITOF with intensity data. RGB camera fusion is really easy, and field-of-



*A lidar intensity image of a forklift. Source: Sense Photonics*

view overlay is promising,” she said. “The entire computer-vision industry can attach depth values at longer ranges to train machine learning.”

“When a human driver sees a dog, that may be efficient, but machines need to know what’s in the scene,” said Bishop. “When you generate an RGB image and have associated depth values across the field of view, computer-vision models become more robust. Our solid-state lidar provides more reliable uniform distance values at long range when synched with other sensors.”



*Lidar plus RGB data for depth perception. Source: Sense Photonics*

“The software stack then gets more reliable for annotation, and if a distance-imaging chip was in every serious camera for security, monitoring a street, or in a car or robot, it could help annotation for machine learning,” she added. Better data would also help piece-picking and mobile manipulation robots.

“Sense Photonics’ software uses peer-to-peer time sync for sensor fusion and robotic motion planning,” Bishop said. “With rotating lidars, you need to write a lot of code to understand images, as the robot and sensor are moving at the same

time. Companies have told us they want low latency and lower power from solid-state systems.”

### **Solid-state lidar applications**

More accurate and rugged solid-state lidar can be useful for warehouse, logistics, and other robotics use cases, especially in truck yards, Bishop said. At MODEX, Sense Photonics demonstrated industrial applications, including security cameras, video annotation, forklift collision avoidance, and supplemental obstacle avoidance.

By combining simultaneous localization and mapping (SLAM) with lidar data, fleet management systems could know about bottlenecks and manage all assets in a warehouse, Bishop said. “They should be warehouse operations systems,” she said. “The big retailers and consultants don’t know the difference between old-school and new-school robotics. Customers don’t know whom to believe when it comes to capabilities.”

“With interference mitigation, our sensors can see mixed-case pallets 3 meters away with 5-millimeter accuracy,” she said. “You can point multiple Sense One sensors at an object, like a pallet or cars passing each other. Most lidar companies don’t have an interference-mitigation strategy.”

“Most mobile robotics people want a wide field of view at 15 to 20 meters,” Bishop said. “We’ll have a 95-by-75-degree, so you can do 180 degrees with two units. It and our Osprey product for automotive will be available soon.”

“Sense offers three different fields of view for a 40 meters range outdoors,” she added. “All you need to do is install cameras to the wire, mount them, and get their security certificates and IP address. For 50 meters indoors, you need only one or two units.”

“Because of its usefulness in sunlight, one agricultural company wants to put Sense Photonics’ LiDAR on a sod mower,” said Bishop. The Sense Solid-State Flash LiDAR is available for preorders now.

“Our intention is to build reasonably priced cameras for integration on consumer-grade advanced driver-assist systems, not expensive ones for experimental use,” she said. “Automotive manufacturers are figuring out which sensors they need and don’t need. They’re now optimizing for only the sensors they need and want to make them invisible.”

**The coronavirus has prompted a radical work-from-home experiment by Microsoft, Apple and other tech giants. But for a growing number of smaller tech companies that have operated remotely for years, the shuttering of offices has had little impact.**

By Nick Wingfield and Kate Clark

Last week, Google, Microsoft, Apple and other big tech companies began encouraging tens of thousands of their employees to work from home, in a dramatic response to help curb the coronavirus pandemic.

Then there are people like Dave McJannet, whose company didn't have to send employees home—because they were already there. McJannet is CEO of HashiCorp, a cloud software company that for years has operated almost entirely remotely, with about 85% of its 900 employees working from their homes, mainly in the U.S. and Canada. The remaining employees—including senior executives, human resources managers and others—are at its headquarters in San Francisco.

“We're completely unimpacted,” McJannet said in an interview last week.

Companies like HashiCorp operate remotely because it makes it easier to recruit people put off by the high cost of living in places like San Francisco, not because of any concerns about contagion. Nonetheless, the strategy has made remote companies especially resilient in a moment when many big employers are scrambling to figure out how their staffers can work effectively from home.

“It's going to be a litmus test of how innovative, agile and adept companies are to change,” said Darren Murph, head of remote at GitLab, a provider of developer tools with 1,225 employees, all of whom work remotely.

The current amount of change may be more than even experienced remote workers can handle. Widespread school closures will mean that many employees will have to juggle work and parenting responsibilities during the day.

It is difficult to predict what the lasting impact of the current radical experiment in remote work will be on the tech industry. Prototypes of new iPhones and other hardware devices from Apple will still need to be created in labs, not home offices, for example. And it is hard to envision all big customer sales meetings happening remotely when the virus abates.

But companies that are longtime proponents of remote work believe the coronavirus outbreak will be a catalyst that leads tech employers to allow more staff to work from home, just as soaring rents and traffic in tech hubs have in the past. “This is another social-economic change,” said Murph. “Going remote acts as a hedge against future events like this.”

While many businesses don't have the luxury of allowing employees to work from home during the pandemic, a lot of tech industry work can in theory be done anywhere. Modern development tools like GitLab and Microsoft's GitHub have made it much easier for programmers to work on software projects from anywhere with an internet connection. Messaging systems like Slack and videoconferencing platforms like Zoom are essential parts of the communications toolbox for remote workers.

A survey of American workers by the polling firm Gallup found that in 2016 43% of employees worked remotely at least some of the time, up from 39% in 2012. Of those remote workers, almost a third spent 80% or more of their time

working remotely in 2016, compared to 24% in 2012. In computer-related professions, 57% did some remote work in 2016, according to Gallup.

That includes tech companies like Automattic, which makes WordPress and other software products and has been almost entirely remote since it was founded in 2005. At one point, it opened a large office in San Francisco for employees who preferred a more traditional work environment, but it got rid of that space in 2016 because of how little people used it.

“We had this 15,000-square-foot place with only five people coming into it,” said Matt Mullenweg, CEO of Automattic, which acquired Tumblr last year.

Now Automattic rents only one small co-working space in a WeWork suite in New York and uses another small office in San Francisco exclusively for board meetings. It manages its remote workforce using Slack and Zoom and gives new employees \$2,000 so they can purchase home office equipment. Employees can also get up to \$250 per month for access to a co-working space or for daily coffees at a local coffee shop. But Mullenweg says only about 300 of the company’s 1,200 employees chose to work somewhere other than a home office.

“I hope there can be a silver lining to this crisis, which we all hope is over as soon as possible, that enables people to reexamine how they work and how they interact with things and improve it,” said Mullenweg. “I’m happy to spread the gospel wherever possible for distributed work. I think it’s better for companies, employees, the environment and the world. There are very few downsides.”

Zapier, a maker of workflow automation tools, has operated with an entirely remote workforce since the company was founded in 2011. Wade Foster, Zapier’s co-founder and CEO, said that allowing a distributed workforce has become a competitive advantage, allowing the company to recruit talent from around the globe while increasing its employee retention rates. Zapier employs about 300 employees in 27 countries.

Zapier gives employees a budget of \$7,500 to invest in their home offices when they begin working at the company, followed by an additional \$6,000 to purchase new technology and other home office equipment every three years. Some companies that recently mandated work-from-home policies due to the outbreak, such as Shopify, have also agreed to give employees money to set up home offices.

Foster is concerned that the current crisis-driven approach will lead to missteps in implementing remote work. That may discourage some companies from sticking with the policy when the coronavirus ebbs. “The one thing I am worried about is that because it’s being foisted upon us, there will be companies that are simply not set up to do this well,” he said. “I worry they will say, ‘Remote can’t work.’”

Even though HashiCorp hasn’t skipped a beat since the outbreak worsened, the cancellation of in-person meetings and the growing travel risks have forced the company to adapt. McJannet said he had sales meetings through Zoom videoconferences last week with two large customers, including a Fortune 50 company, instead of meeting them in person.

Both meetings ended with the customers asking McJannet to send them enterprise sales contracts, a sign that the deals are likely to close. Undoubtedly, cutbacks to travel will affect some businesses negatively, and a broader economic downturn will hurt sales at even the most promising tech companies. Slack, for instance, on Thursday warned that travel disruptions may hurt its ability to close large customer deals. When the current crisis subsides, McJannet expects to resume business travel, especially to see customers. It’s difficult to build trust over videoconference calls, he said. Still, he predicted he will travel less if the company finds it can effectively conduct customer meetings remotely.

“What Zoom will prove to us is I probably didn’t need to travel that much anyway,” he said.

By Alicia K. Quesnel and Robyn A. Finley

In Canada, the production of propane, a hydrocarbon that, in its liquid state, falls within the category of liquefied petroleum gases (LPGs), is on the rise. Between 2015 and 2018, propane production in Alberta increased from 7,958,621 cubic metres to 12,610,330 cubic metres, an increase of almost 37 percent. While this is principally due to the growth in liquid rich natural gas production in the Montney region, it is also the result of the closure of Canada's principal propane export pipeline, the Cochin pipeline, in 2014. Prior to April 2014, most propane produced in western Canada was exported to US markets on the Cochin pipeline. In April 2014, the Cochin pipeline was reversed to transport light petroleum liquids from the US to western Canada. Exports of propane to the US dropped dramatically, leading to an oversupply of propane in Canada and resulting in much lower propane prices.

Propane is also considered a greener, cleaner source of energy as it emits 60 percent less carbon monoxide than gasoline, 98 percent less particulate matter than diesel, and contains virtually no sulphur – a contributor to acid rain. Furthermore, propane is a pressurised fuel that must be contained within a sealed system, and in the event of a spill, becomes a vapour that does not contaminate the soil, air or aquifers. Unlike natural gas, propane is not a greenhouse gas in its unburnt state. These attributes are an important part of the world's transition to a lower carbon economy.

Propane's abundance in western Canada, its lower price and its characterisation as a cleaner energy source, have presented new opportunities for the growth of the propane industry in Canada, primarily as a source of supply for propane-hungry regions in Asia, such as China, India and Japan, and as feedstock for the petrochemical industry in Alberta. The increased supply of propane is supporting the development of these new markets, while at the same time, new opportunities are creating increased demand for propane production.

### **Diversifying Canada's export markets**

In North America, propane has been primarily used for heating and crop drying, and so demand is seasonal and variable, peaking in the autumn and winter. Globally, however, demand from Asia accounts for 45 percent of the world's LPG consumption, with China being the largest LPG importer. Sixty percent of Asia's LPG demand is for use in residential cooking and heating, with the remaining demand divided among commercial use, petrochemical companies and propane dehydrogenation operations that make propylene for the plastics industry.

Following the closure of the Cochin pipeline in April 2014, most of Canada's propane was exported by rail, with much smaller volumes transported by pipeline or by truck. Until 2019, nearly all of Canada's exported propane was exported directly to the US. On 23 May 2019, the first ever shipment of propane from a Canadian port departed the Ridley Island Propane Export Terminal (RIPET) bound for Japan. RIPET is a joint venture between AltaGas Ltd and Vopak Development Canada Inc.

RIPET is the first of four propane export terminals proposed for Canada's west coast. Pembina Pipeline Corporation (Pembina) is currently building the Prince Rupert Export Terminal on Watson Island in British Columbia, with exports expected to begin in the second half of 2020. In February 2020, Pembina announced plans to expand the Watson Island facility to have greater export capacity. The expanded terminal is expected to be in service mid-2023. The other two terminals, a second terminal on Ridley Island proposed by Royal Vopak, and Pacific Traverse Energy's terminal at Kitimat, British Columbia, may come online in 2022. As the west coast of Canada is the closest location for LPG terminals to Asia, and given the construction of LPG terminals there, there is an opportunity for western Canadian propane producers to diversify their market access to Asia, a premium market for propane.

Demand from Asia accounts for 45 percent of the world's LPG consumption, with China being the largest LPG

importer. Since 2010, as a result of the shale boom, the US has become the world's leading exporter of LPGs, with most shipments bound for China, India and Japan. Sixty percent of the LPGs imported into Asia are consumed by residential and commercial customers for cooking and heating, but the manufacturing sector is also a significant importer of LPGs. In 2019, LPGs from the US accounted for 37 percent of Asia's total imports, and 70 percent of the LPGs imported into Asia consisted of propane. Most of the US's propane exports depart from the Gulf coast, and reach Asia via the Panama Canal, but for one propane export facility on the west coast in Ferndale, Washington that is operated by Petrogas Energy Corp.

A shipment of LPGs from the west coast of North America takes 10 days to make a Pacific crossing, whereas shipments from the US's Gulf Coast take 25 days to reach Asian ports. Ocean freight to Asia from British Columbia costs much less than from the Gulf Coast and via the Panama Canal. Furthermore, considering the US's and China's ongoing trade disputes, Chinese buyers may become more interested in buying Canadian LPGs through which they could enjoy cheaper freight rates due to the shorter distance across the Pacific.

### **Supporting the growth of Canada's petrochemical industry**

The growth and development of Alberta's petrochemical industry was supported by the abundance of ethane as a feedstock for the production of ethylene and polyethylene, the world's most popular form of plastic. Today, with a view toward a cleaner, greener economy, polypropylene, which uses propane as its feedstock, is a widely used plastic, preferred for its durability and its recyclability. Polypropylene is an element of many common goods, including consumer packaging, automobile parts, medical equipment, currency and textiles. Canada has never produced or exported polypropylene, but with an abundance of supply and relatively low prices, two propane dehydrogenation plants and polypropylene upgrading facilities are under construction, which when in-service, will allow Canada to process domestic propane and participate in the global polypropylene market. Notably, polypropylene ships in the form of plastic pellets, which are inert and can be transported alongside other products in generic shipping containers. One multi-purpose rail car used to transport polypropylene beads could replace nearly two specialised rail cars currently used to transport propane, thus creating additional rail capacity for substances that require pressurised cars.

Inter Pipeline Ltd has begun construction on the Heartland Petrochemical Complex in Hardisty, Alberta, a propane processing facility that is designed to convert locally sourced propane into polypropylene (the Heartland Complex). Science and Economic Development Canada estimates that Inter Pipeline's process of converting propane into polypropylene will displace 1.75 million tonnes of carbon dioxide per year. In March 2019, the Canadian government announced a commitment of \$49m to the Heartland Complex, as part of a \$1.6bn stimulus package for the oil & natural gas industry. Also in March 2019, Inter Pipeline was awarded \$70m in royalty credits from the government of Alberta, in addition to the \$200m it was awarded in 2016 from the Province of Alberta's Petrochemicals Diversification Programme, upon completion of the Heartland complex, which is scheduled to begin operating in 2021.

Canada Kuwait Petrochemical Corporation is a joint venture between Pembina and Petrochemical Industries Company K.S.C. of Kuwait. In February 2019, CKPC received a positive final investment decision on its propane processing facility in Sturgeon County, Alberta (the CKPC Complex). In March 2019, the Canadian government announced a commitment of \$49m to the CKPC Complex. CKPC will invest \$7m into initiatives aimed at reducing plastic waste as a contribution to Canada's environmental goals. In December 2016, CKPC was awarded \$300m in royalty credits from the Province of Alberta's Petrochemicals Diversification Programme upon completion of the CKPC Complex. The CKPC Complex is scheduled to begin operating in mid-2023.

Both Inter Pipeline and CKPC anticipate exporting polypropylene produced at the Heartland Complex and the CKPC Complex to the US, where Inter Pipeline forecasts that polypropylene will sell for the highest price worldwide. This prospect suggests a positive shift for the Canadian propane industry, which has historically been limited by a lack of export options that exerted downward pricing pressure on Canadian propane exports to the US.

### **A case for optimism**

As natural gas continues to be produced in Canada, and the demand for greener energy sources grows louder, the prospects for Canada's propane industry remain positive.

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*Alicia K. Quesnel is a partner and Robyn A. Finley is an associate at Burnet, Duckworth & Palmer LLP. Ms Quesnel can be contacted at +1 (403) 260 0233 or by email: [akq@bdplaw.com](mailto:akq@bdplaw.com). Ms Finley can be contacted at +1 (403) 260 0186 or by email: [rfinley@bdplaw.com](mailto:rfinley@bdplaw.com).*

By Kelly Hill

**LTE just became the dominant mobile network technology last year, but the industry is already looking ahead**

Mobile network operators are projected to invest more than \$1.1 trillion in their networks over the next five years, and about 80% of that will be in 5G technology, according to a new report from GSMA Intelligence. The industry is putting a lot of time and money into the next generation of wireless technology, even as LTE only became the dominant network technology last year. 2019 was the first year when LTE connections accounted for more than half of mobile connections, hitting 52%; that figure for LTE connections is projected to hit 56% by 2025.

Meanwhile, the report projects that 5G will account for 20% of global connections by 2025, with particularly strong uptake in developed Asia, North America and Europe. The report says that the needle will start to move on 5G connections beginning this year.

Ana Tavares Lattibeaudiere, head of North American operations for the GSMA, said that the report reflects a relatively fast 5G roll-out in the U.S., compared to other regions—even though the technology deployments and the services that will ultimately be developed for them are still in early days overall.

“When you think about all the services that 5G could bring, it’s just scratching the surface right now,” she said.

While the first thing people think of with 5G is increased broadband data speeds, she added, it has the potential to have widespread social impact on people’s lives, through being applied in areas such as education and healthcare.

The GSMA Intelligence report also pointed out that other network improvements, such network slicing, edge computing and lower latency, “are not widely appreciated” and many companies believe that “4G remains ‘good enough.’”

“Most of the key benefits for enterprises won’t come until standalone 5G is deployed,” the GSMA Intelligence report added, but telecom companies need to start conversations now and lay a foundation to help businesses understand the problems that 5G will be able to solve. “As this is a highly competitive area given the presence of Amazon, Microsoft, Google and other cloud companies, speed to market is an important factor,” the report said.

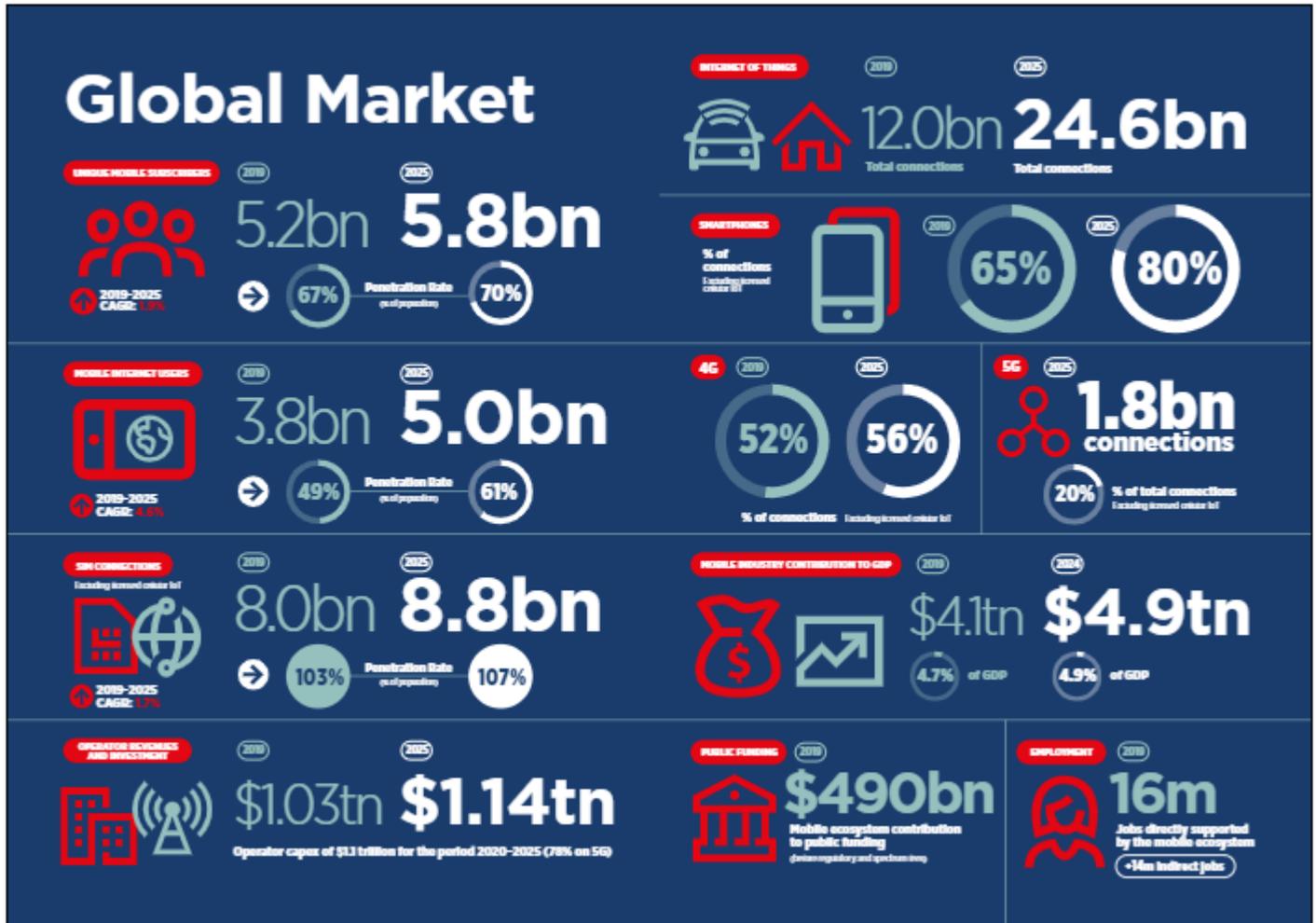
“I think there’s a whole new set of services that can come to the enterprise, that 4G wasn’t able to deliver,” Tavares Lattibeaudiere added.

Other findings of the report include:

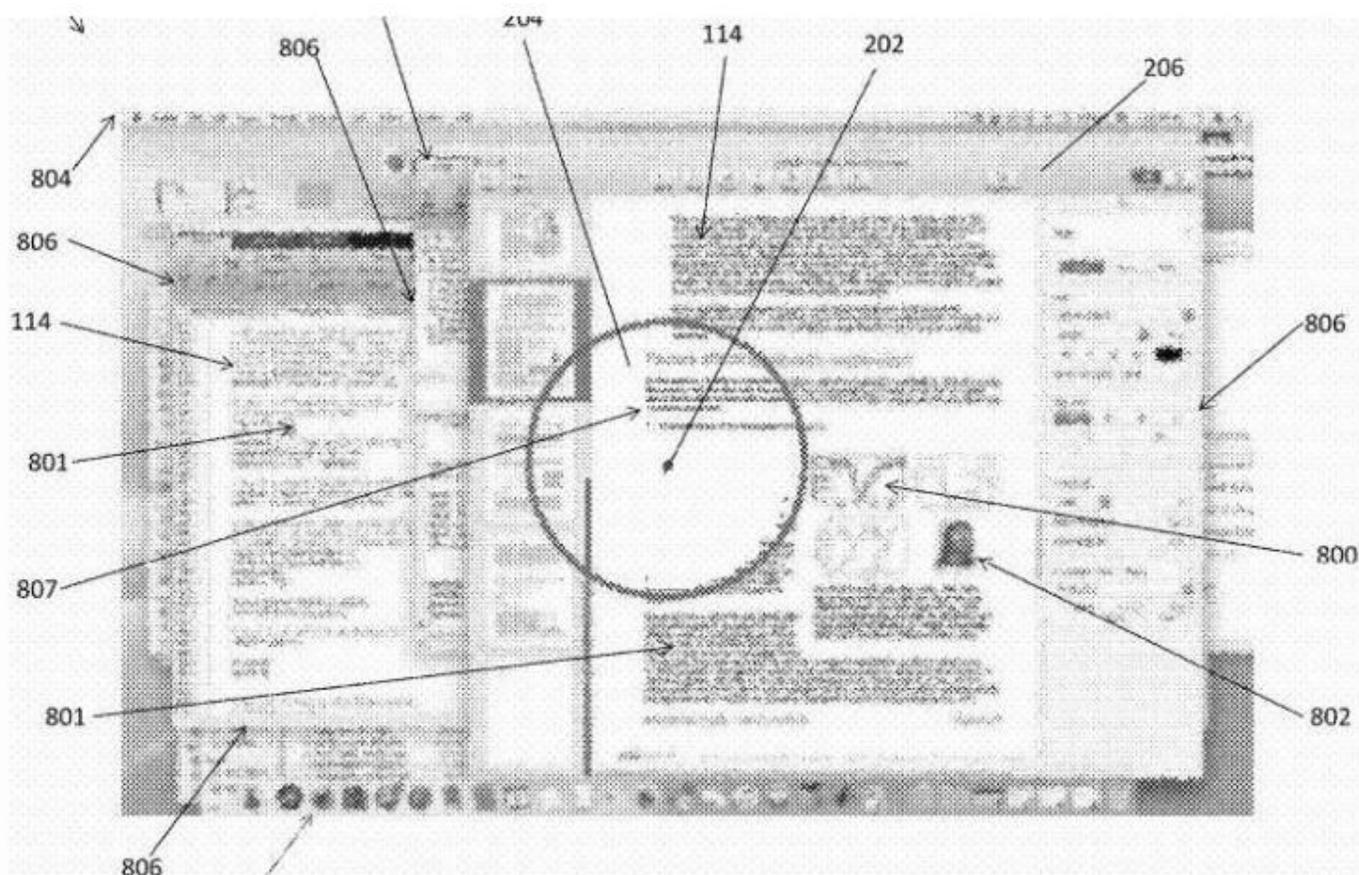
- The global appetite for upgrading to 5G, and paying more for it, varies widely.”In general, consumers in South Korea, China and the Middle East tend to be the most willing to upgrade to 5G, while those in the U.S., Europe and Japan seem satisfied using 4G for the time being,” the GSMA Intelligence report said. The report estimated that by 2025, half of 5G connections will be in developed Asian nations, with North America close behind at 48% of 5G connections.
- There is still a global “coverage gap,” with about 9% of the global population or 673 million people who don’t get live within the footprint of a mobile network. GSMA Intelligence also identified a “usage gap,” of people who are covered by at least one mobile network but don’t use them.

- IoT will be an “integral” part of 5G, and the smart home is a “critical battleground,” the report said, where fragmentation is a challenge to integration and adoption — but early signs indicate that smart speakers are likely to play a central role in a “smart home revolution in 2020.”
- GSMA Intelligence said that as of the end of 2019, 5.2 billion people were using mobile services, or 67% of the global population. That is expected to rise to 5.8 billion by 2025, with most of the new growth in subscribers coming from China, India, Pakistan and Nigeria.

Check out the accompanying infographic for the report below:



By Peter Grad



Credit: United States Patent Application 20200081527

Secret digital intrusions into our computers and mobile devices have garnered increasing attention in recent times. But a decidedly lower-tech assault has also been troublesome: shoulder surfing. You know the types: friends, work colleagues and assorted passers-by who walk by you and can't resist quietly peeking over your shoulder at the content of your screen while you're blasting the boss, watching cartoons or recounting last night's passionate encounter with your lover.

As Martin Cooper, known as the father of the handheld cellphone, once put it: "Privacy is a thing of the past."

It was reported this week that Apple has its eye on the problem. A recently uncovered patent application by the tech giant reveals it is looking into a technology that will distinguish between user and unwanted onlookers and blur screen content not intended for unauthorized eyes.

Called "Gaze-dependent display encryption," the app would utilize face recognition to determine the owner of the device and eye-tracking to determine what segment of the screen the authorized viewer is scanning at the moment. When unknown faces appear, either directly in front of the device or in the background, gaze encryption would be activated.

For instance, if an authorized viewer is reading a screen and a snooper appears in the background, eye-tracking will leave currently viewed spots untouched while it renders the remainder of the screen indecipherable to onlookers. The obscured segments will resemble the text or image displayed, but scramble it sufficiently to be indecipherable. Such manipulations will include text scrambling, color altering and image warping.

The app will likely be initially applied to iPads, iPhones and desktop units, but may well be used on wearable devices such as smart watches.

Recent efforts to control unwanted snooping include the Blackberry phone's commendable Privacy Shade feature introduced in 2018. Tapping a button allows you to display a limited area while blotting out the remainder of the screen. Text within a narrow horizontal or circular rectangular area displays normally, while the user controls the opacity of the remainder of the space.

HP introduced its own version of Privacy Shade a year earlier in its EliteBook x360 laptop. Tapping a button allowed the screen to be viewed solely by a viewer looking directly at it; the screen darkened and blurred if viewed from any angle off-center.

Snooping has a long, colorful history, from the days 1,000 years ago where entire families, visiting relatives and friends—and even animals—witnessed everyone else's business in homes that had no walls and where humans and beasts occupied the same room. Early phones in homes relied on "party lines," shared wires on which anyone could quietly eavesdrop on neighbors. And with the introduction of postcards, some 200,000 New Yorkers purchased them the first day they were offered in May 15, 1873, spilling often intimate details on sheets of cardboard that could be read by postal workers and mail carriers.

And many may remember the 1960's TV spy-comedy "Get Smart," where bumbling Agent Maxwell Smart routinely entered the room-sized "cone of silence" for highly confidential exchanges with fellow spies. The running gag was that the room made it impossible for the cone occupants to hear one another, while their conversation was easily picked up by all outside the room.

It's too early to know when or even if Apple will implement the new anti-snoop technology. Apple submits many patents that never see light of day.

But given increasing attention to the problems of privacy—Intel CEO Andrew Grove years ago observed that "privacy is one of the biggest problems in this new electronic age"—Apple will likely aggressively pursue this and other innovative solutions to an age-old problem.

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**More information:** GAZE-DEPENDENT DISPLAY ENCRYPTION, [United States Patent Application 20200081527](#)

By Ingrid Fadelli

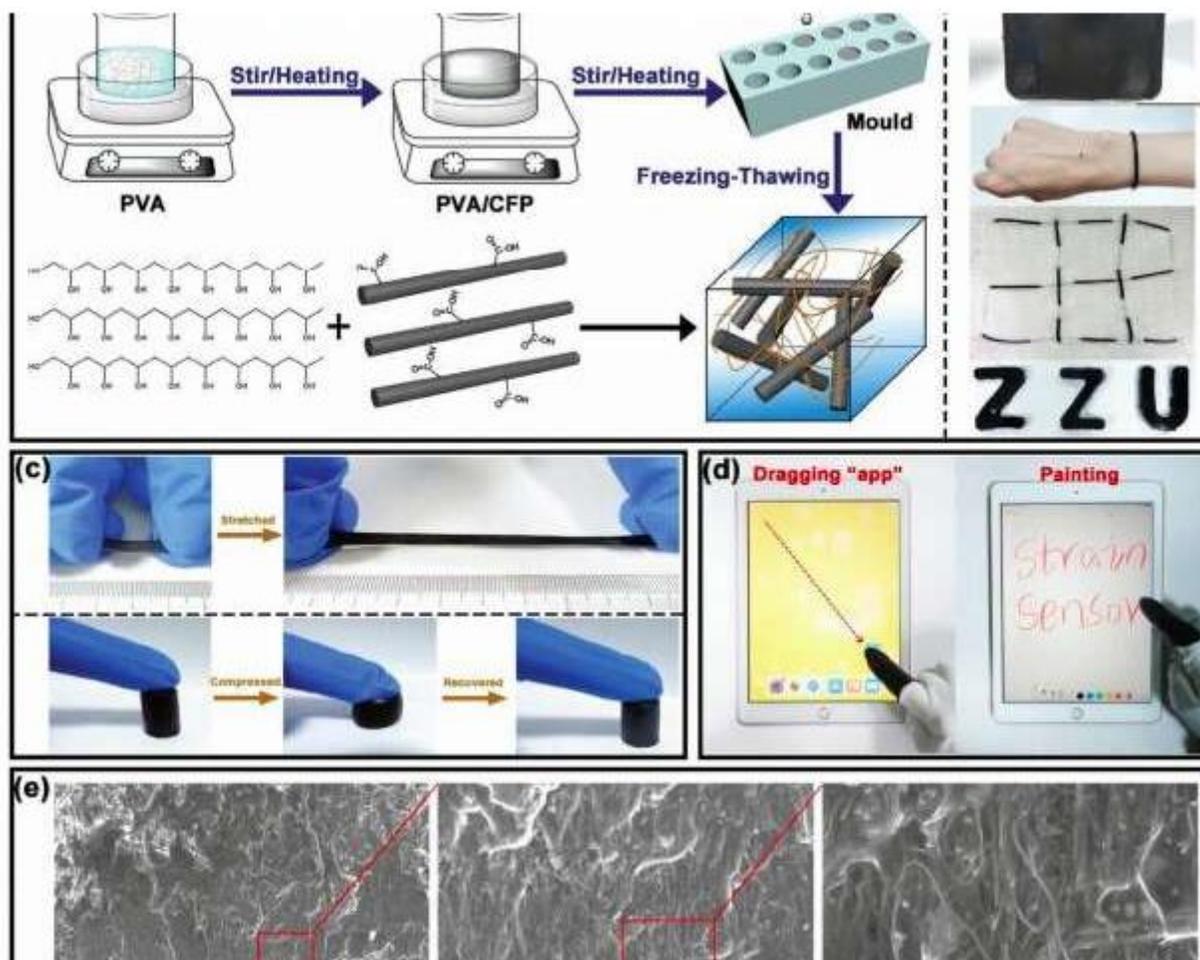


Figure showing how the highly processable PVA/CFP hydrogel was fabricated and outlining some of its characteristics. Credit: Cheng et al.

Recent technological advances have enabled the development of increasingly sophisticated electronics. Some of these new tools, particularly wearable devices and soft robots, require or can greatly benefit from flexible electronic components, including sensors, actuators and supercapacitors.

Researchers at Zhengzhou University and Peking University in China have recently developed a new stretchable and compressible hydrogel strain sensor that could be used to fabricate a variety of flexible or soft technologies with sensing capabilities, including health trackers and robotic skins. This sensor, presented in a paper published in *Macromolecular Materials and Engineering*, is both easy to fabricate and affordable, which makes it ideal for large-scale implementations.

The researchers created it by uniformly dispersing carbon nanofiber powder (CFP) inside a polyvinyl alcohol (PVA)-based hydrogel. PVA has so far proved to be highly promising for the development of flexible electronics due to its advantageous mechanical properties and the fact that it is biodegradable.

By dispersing CFP inside the PVA-based hydrogel, the researchers were able to enhance the material's mechanical strength and increase its electrical conductivity. They employed what is known as a 'freezing-thawing cycle' method, which entails repeatedly freezing and thawing a substance.

The PVA/CFP hydrogel produced from this process was found to exhibit a wide stretching (366%) and compressing (70%) range. This makes it ideal for the development of highly flexible electronics, which can be stretched or compressed while maintaining optimal sensing capabilities.

"During 1000 loading-unloading cycles, the PVA/CFP hydrogel has a low plastic deformation (<10%, for both stretching and compressing), small energy loss efficiency (5.62% under stretching and 12.13% under compressing), and a stable mechanical strength and excellent sensitivity, whether it is stretched to 100% or compressed to 50% strains," the researchers wrote in their paper.

In addition to being fairly straightforward and effective, this method for fabricating stretchable and compressible sensors is low-cost, and could thus be easily scaled up. Moreover, it enables the development of highly performing sensors that can detect a wide range of human behaviors or activities.

For instance, sensors created using the new fabrication strategy can accurately detect when a user is bending or stretching his/her joints, breathing, and swallowing. They can also sense the changes in pressure that take place when humans are walking or moving.

The researchers tested their sensors in several scenarios, placing them on a user's wrist to detect the tensing of fist muscles, on the throat to monitor swallowing, on the stomach to detect breathing, or under the sole of shoes to monitor the user's walking behavior. They also used the same sensors to detect a human's touch and when he/she pressed on the sensor.

The carbon nanofiber-polymer hydrogel strain sensor has already achieved highly promising results, highlighting its potential for a variety of applications. In the future, it could be used to develop new wearable devices, such as smartwatches and health trackers, but it could also enable the fabrication of stretchable electronic skins with advanced sensing capabilities.

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**More information:** Baowei Cheng et al. Highly Stretchable and Compressible Carbon Nanofiber–Polymer Hydrogel Strain Sensor for Human Motion Detection, *Macromolecular Materials and Engineering* (2020). [DOI: 10.1002/mame.201900813](https://doi.org/10.1002/mame.201900813)

## **Loihi chip programmed to mimic neural structure of mammalian scent organ**

By Saamuel K. Moore

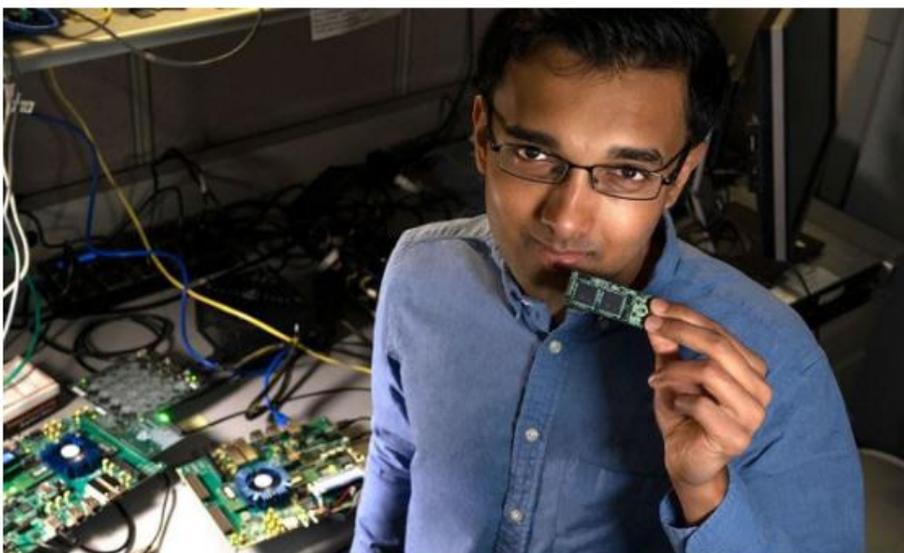


Photo: Walden Kirsch/Intel

Intel Labs' Nabil Imam holds a Loihi neuromorphic test chip. The team is building algorithms on computer chips to mimic what happens in your brain's neural network when you smell something.

works than the architectures of CPUs or even new accelerator chips designed to speed deep learning. Researchers hope that such neuromorphic chips will be able to do things that today's AI systems can't do, or at least can't do without consuming a lot of power or taking too much time.

One of those things is called "one-shot" learning. Your nose can smell something once, and your brain will immediately recognize it again. But today's AI systems, which often use deep learning artificial neural networks, must be trained using a huge number of previously identified examples. That makes training a time-consuming, power-hungry process. Even worse, most previously trained AI cannot easily learn a new category without damaging its memory of the old ones, meaning it needs to be completely retrained with all the categories.

Unlike the artificial neurons in today's AI, Loihi's neurons carry information in the timing of digitally-represented spikes, which is more analogous to what goes on in your brain.

In 2019, Intel announced a multi-chip Loihi system comprising 64 chips and the equivalent of 8 million neurons. Intel has plans for a 768-chip 100-million neuron system. (Intel's director of neuromorphic research hinted at the neuromorphic nose's ability when the 8-million neuron system was announced last year.)

According to Intel senior research scientist Nabil Imam, the next step is "to generalize this approach to a wider range of problems—from sensory scene analysis (understanding the relationships between objects you observe) to abstract problems like planning and decision-making. Understanding how the brain's neural circuits solve these complex computational problems will provide important clues for designing efficient and robust machine intelligence."

Researchers at Intel and Cornell University report that they've made an electronic nose that can learn the scent of a chemical after just one exposure to it and then identify that scent even when it's masked by others. The system is built around Intel's neuromorphic research chip, Loihi and an array of 72 chemical sensors. Loihi was programmed to mimic the workings of neurons in the olfactory bulb, the part of the brain that distinguishes different smells. The system's inventors say it could one day watch for hazardous substances in the air, sniff out hidden drugs or explosives, or aid in medical diagnoses.

Loihi's chip architecture is meant to more closely match the way the brain

However, there are challenges to overcome first. In particular, the system needs to be able to group different, closely related aromas, into a common category. For example, it needs to be able to tell that strawberries from California and strawberries from Europe are the same fruit. “These are challenges in olfactory signal recognition that we're working on and that we hope to solve in the next couple of years before this becomes a product that can solve real-world problems beyond the experimental ones we have demonstrated in the lab,” Imam said in a press release.

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Imam and Cornell University olfactory expert [Thomas A. Cleland](#) reported the new system this week in [Nature Machine Intelligence](#).

By Kevini Dowd

Well, that was quite a week. And it looks like it's going to be quite a year.

The new coronavirus that first appeared in China nearly four months ago is now officially a pandemic, and the US is finally beginning to grapple in earnest with what could be the nation's most destructive public health crisis in more than a century. The stock market spent much of the week in freefall, giving up nearly three years' worth of gains in the span of four days before a late Friday surge. Sports are essentially canceled. Tom Hanks is sick. Who knows what's going on in the White House. And doctors and scientists are loudly sounding the alarm that things will likely get much worse before they get better.

This is still a newsletter about venture capital and private equity. But it was a bit difficult this week to focus on startups and buyouts as the world careered closer to total chaos.

It's a mad world out there, which is one of 10 things you need to know from the past week:

### **1. A whirlwind week**

It's always a strange feeling to live through history. As cities across the US clamped down on group gatherings and the stock market experienced its worst day since 1987's Black Monday, one part of me was extremely aware the events filling up my Twitter feed would be remembered for the rest of my life, and probably much longer. Another part was wondering whether I still had enough turkey in the fridge to make a sandwich. It's a weird dissonance when world-historical events start overlapping with your lunch plans.

The week brought a ceaseless cascade of news. The entire nation of Italy is under quarantine. Markets cratered across the globe. In the US, the lack of testing for COVID-19 is becoming a national stain. Schools are closing for weeks. The Fed's announced plans to inject \$1.5 trillion into the economy only managed to quell Thursday's market rout for about 90 minutes. On Friday, the US declared a national emergency.

Within a single half-hour on Wednesday night, Tom Hanks announced he and wife Rita Wilson had both tested positive for the virus, the president of the US announced a ban on travel to and from Europe (major parts of which were later retracted), and the NBA season was suspended after a player's positive test.

It was enough to make you want to go out for a drink. Except here in Seattle, where I live, even the most casual public gathering now comes with the moral hazard that "you might be killing your grandad" by unwittingly spreading the disease, as our Gov. Jay Inslee put it this week.

There were of course immediate impacts of the growing outbreak for the companies and investors that populate the private markets. Buyout giant KKR temporarily closed offices after employees tested positive for the virus, and Bain Capital is believed to have done the same. Venture firms intensified preparations for a recession. Private equity stocks tumbled. The Bill & Melinda Gates Foundation teamed with Wellcome and Mastercard to launch a \$125 million fund that will be invested in companies working on coronavirus treatments. Everyone who can is now working remotely—or else they really, really should be.

And more will be to come, because this pandemic probably isn't going anywhere. Experts believe 200 million Americans could be infected and 1.5 million could die over the course of the outbreak, and that's not even the highest end of their estimates. "The bottom line: It is going to get worse," Dr. Anthony Fauci, the director of the

National Institute of Allergy and Infectious Diseases, said this week before Congress. "We must be much more serious as a country about what we might expect."

One impact may be the mainstreaming of remote work. A year ago at this time, Zoom Video Communications was an under-the-radar video chat startup mulling an IPO; now, "Zoom" seems well on its way to becoming a verb, à la "Google it," and the company is worth nearly \$30 billion. It was one of the few publicly traded companies to weather this week's storm, with its stock price actually closing Friday up 2.3% from Monday's open.)

Other startups are trying to capitalize. This week brought news that a company called Confluent, the creator of an event-streaming platform, is seeking to raise somewhere between \$200 million and \$300 million in new funding at a valuation that could reach \$5 billion. Enterprise software was already emerging as a red-hot sector in Silicon Valley, and the current crisis will likely create new opportunities for tech that changes the way businesses operate.

But it feels rather gauche and grimy to be overly concerned at this point with potential profits. For me, even the stock market turmoil is a secondary story. (Although to be fair, my personal portfolio losses this week amounted to about the price of a 10-year-old Honda Accord; some people's finances took a much sharper hit, to put it mildly.)

It's the coronavirus that could be a literal matter of life and death for millions of Americans. And while the delayed response in the US seems to mean that the window for true containment of the disease has vanished, there are still things we can all do to help our fellow citizens and ourselves. Listen to doctors. Listen to scientists. Avoid groups. Stay home if you can. Check in on your loved ones. Take care of each other.

It would sure be easier (for me, at least) if we still had March Madness to distract ourselves in the coming days. But the world changed this week, and it might be quite some time before it returns to normal.

## **2. Sequoia strangeness**

A Silicon Valley icon was involved in a very strange story this week. Sequoia reportedly walked away from a \$21 million investment made earlier this year in a payments startup called Finix, after belatedly realizing that some might see a real conflict of interest between Finix and Stripe, a longtime Sequoia portfolio company. Finix will keep Sequoia's money despite the parting of ways, effectively turning the recent deal into an eight-figure act of charity.

## **3. Aon in flux**

The stock market shambles on Monday didn't stop a pair of British insurance giants from lining up what PitchBook data indicates is the biggest merger so far this year, as Aon inked an agreement to acquire Willis Towers Watson in an all-stock agreement originally valued at about \$30 billion. Aon's shares closed the week down 10.6% from Monday's opening price, however, knocking a few billion off the prospective price tag for the combination.

## **4. Quibbles with Quibi**

Quibi is a short-form streaming startup that's reportedly already raised \$1.75 billion in advance of a launch scheduled for next month. But it ran into hot water on Tuesday, when interactive video company Eko filed a lawsuit accusing Quibi of stealing video-rotation technology that Eko had previously demoed for Quibi founder Jeffrey Katzenberg. Quibi seems to have known the suit was coming: A day prior, it filed a lawsuit of its own asking the courts to rule that Quibi's tech doesn't infringe on any Eko patents.

## **5. A toy tilt**

In other litigation news, a group of Toys R Us creditors and former suppliers filed a lawsuit this week accusing KKR, Bain Capital and other Toys R Us backers and executives of "breaches of fiduciary duty, fraudulent concealment, misrepresentations, and negligence" that helped contribute to more than \$1.75 billion in unpaid pre-bankruptcy claims and some 31,000 lost jobs. It's hard to summarize a 111-page lawsuit in two sentences, so here's a more detailed breakdown.

## 6. Twitter's truce

A potential activist battle between Twitter and Elliott Management came to a quick conclusion this week, when Twitter announced a new partnership with Elliott and Silver Lake that involves three new board members and plans for \$2 billion in stock buybacks. The deal also leaves Jack Dorsey in the CEO role, allowing him to dodge the ignominy of being forced out for the second time from the company he helped create.

## 7. Tesco & Tegna

British supermarket giant Tesco agreed this week to sell its Thai and Malaysian subsidiaries for \$10.6 billion to a company owned by Thai billionaire Dhanin Chearavanont, who previously owned the Lotus supermarket chain before selling it to Tesco more than 20 years ago. American broadcast company Tegna, meanwhile, was at the center of a multibillion-dollar bidding war this week, with Apollo Global Management and Byron Allen (a comedian turned media tycoon) reportedly entering rival offers.

## 8. Piles of powder

The week of financial havoc didn't stop NEA from closing its largest venture capital fund ever, a \$3.6 billion vehicle that has reportedly been in the works for about a year. The new fund is the firm's 17th flagship effort, representing a marginal step-up from a \$3.3 billion predecessor that closed in 2017.

## 9. Next steps

This week brought changes of plans for a pair of much-hyped unicorns that have encountered some real bumps in the road in recent months and years. At Juul Labs, co-founder James Monsees is said to be stepping down following a 2019 in which the company was hit with several lawsuits related to illegally marketing its products to minors. Meanwhile, Magic Leap is considering a sale that could value it at more than \$10 billion, according to Bloomberg, a figure that would surely qualify as a win for the VR and AR company after years of skepticism about its products.

## 10. Fizz funding

Last fall, Coca-Cola announced plans to launch a Coke-branded energy drink in 2020. This week brought a presumptive response from PepsiCo: The beverage giant agreed to acquire Rockstar Energy for \$3.85 billion, bringing one of the most popular high-caffeine options on the market into its ever-expanding portfolio.

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## Why Mobile Robots Should be Deployed in Manufacturing Plants?

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Source: Pratik Kirve, Sr. Specialist - Content Writer at Allied Analytics LLP



Mobile robots have gained huge prominence in manufacturing plants owing to its benefits such as safety of humans and demand for high efficiency. The advancements in technology have enabled manufacturers to develop robots suitable to their operational needs and carry out their implementation for their applications. Different benefits in warehouses and logistics would reduce manpower and eliminate errors occurring from humans. Various reasons such as fatigue and lack of judgment can be fatal to ruin specific tasks and can cause injury to humans along with financial losses. Deploying robots to perform such tasks can be a crucial step in reaping various benefits such as flexibility, scalability, safety, and financial gains. Knowing how they can benefit and implementation for right tasks can save a great deal of efforts and provide financial benefits. The demand for mobile robots is increasing across the globe. According to the research firm Allied Market Research, the global mobile robotics market is expected reach \$39.58 billion by 2026. The emergence of industry 4.0 will be a crucial reason for the significant growth of the industry.

Following are some of the crucial benefits of mobile robots:

### **Enhanced flexibility**

As on-board sensors and cameras are utilized in robots for their operations, they offer agility and flexibility. It does not follow the predetermined paths; it creates its own dynamic and efficient pathways from a particular point to the destination by tackling obstacles. This flexibility can also be gained in terms of switching from one task to another with ease and less time. Many automation technologies need time and effort for reprogramming. With the shortest path and less time taken for reaching destinations, the flexibility benefits can be reaped in warehouses and huge manufacturing plants.

### **Increase in safety**

Mobile robots are equipped with different types of sensors and cameras. These enable the safety in its operation. It avoids different obstacles by interpreting the environment, understanding different scenarios, and finding its way. On the other hand, if manpower is used for specific tasks such as forklift, many of which do not have inbuilt safety mechanism and need human inputs, there is a possibility human can experience fatigue or get distracted during the process. However, these issues are eliminated with mobile robots. If they are utilized for repetitive tasks, it can eliminate the possibility of human error along with improving the safety of overall manufacturing plant. The safety mechanism can be fed during the programming and it can be used for ensuring the tasks are carried out by taking the safety in consideration.

**Better scalability**

As mobile robots can be programmed for tasks such as picking up items and dropping them at destinations for few items, they can be reprogrammed for more items. The implementation of modular deployment system is possible with the increase in operational needs. This enables manufacturers to avoid high initial investment costs as they can purchase mobile robots as per the increasing need instead of investing the huge amount. As there is no need for investment initially, manufacturers can utilize the costs for other initiatives or departments. After analyzing the impact of the mobile robots on the business, manufacturers can take decision on whether there can be more deployment.

**Ease in shifting between facilities**

Many manufacturers do not opt for automation as they need to move them to new facilities if need arises. If an automation system is purchased and the company needs to shift to new facility in the next three years, the whole system needs to be dismantled to move. This incurs the cost and time required for dismantling and mantling, and moving to another place. However, mobile robots are easy to move and will not take much efforts to move from one place to another. They can be moved to another place with relative ease as compared to other systems. Even if there is automation required for a short time, the mobile robots become the ideal option for deployment. Even when a temporary operation is required, these robots can be deployed as a solution for some time. Depending upon the specification of the operation, these robots can be ready within weeks and implemented.

**Manfred Green, who has tested vaccines for Health Ministry, warns a hastily made shot could cause adverse effects, erode public faith in inoculations**

By Nathan Jeffay



A hospital employee wearing protection mask and gear shows a swab, a cotton wab for taking mouth specimen, used at a temporary emergency structure set up outside the accident and emergency department, where any new arrivals presenting suspect new coronavirus symptoms will be tested, at the Brescia hospital, Lombardy, on March 13, 2020. (Miguel MEDINA / AFP)

A coronavirus shot is more than 18 months away, and attempting to accelerate the process could be “very risky,” a former vaccine evaluator has told The Times of Israel.

Manfred Green said he understands the public pressure for relaxing testing procedures, given the scale of the pandemic. But a badly tested vaccine could have “adverse effects,” he argued.

Green, who has conducted vaccine tests for Israel’s Health Ministry, said: “If a vaccine is developed in the next few months, you can imagine if there were a one in 1,000 or one in 10,000 adverse reaction. That could be very problematic if you’re giving it to millions of people.”

He made his comments on Sunday, as the race to develop and test a vaccine is intensifying — even to the point of generating international friction. German media reported that the Trump administration has offered the German company CureVac “large sums of money” in return for exclusive access to their work.

In Israel, ever since the Science Ministry made headlines two weeks ago by saying that a state-funded institute’s vaccine could be three months away, there is excitement about the research and widespread support for accelerated testing. In America, the Food and Drug Administration has signaled that it is open to speeding up normal processes.

“When responding to an urgent public health situation such as novel coronavirus, we intend to exercise regulatory flexibility and consider all data relevant to a certain vaccine platform,” FDA spokeswoman Stephanie Caccamo said in a statement.

But Green believes that if a vaccine is to be safe, it needs a long verification period. He stressed that initial tests don’t even deal with whether a vaccine is effective, but just verify that it doesn’t harm people.

“You wouldn’t want to be giving large numbers of people a vaccine when you’re not convinced it’s safe, so you’d have to test it on a large number of people over a long time,” he said. “And that’s before you test its efficacy.”

He said that a coronavirus vaccine could actually take longer than other vaccines to test. His logic is that while new vaccines commonly use long-established technology, coronavirus differs from familiar viruses and a vaccination is widely thought to require new technology.

“If it’s a new technology, not just a new vaccine, we don’t know much about it and we need to learn about it. That would require more extensive testing,” said Green, director of the University of Haifa’s international master’s program in public health, and previously head of the Public Health Branch for the IDF and founding director of the Israel Center for Disease Control.

Prematurely approving a vaccine that turns out to prove problematic would not only have a health cost, but also impact confidence in inoculations, Green said. He noted that in 1976 the US government initiated a widespread vaccination campaign against an expected flu threat, but stopped it when the vaccine was associated with a syndrome that causes paralysis, respiratory arrest, and death. “People lost faith in vaccines at the time,” said Green.

Green thinks that testing aside, the public and researchers are underestimating the complexity of the science needed for a vaccine.

“For the lay public this seems to be a panacea,” he said. “People know we have vaccines, but don’t know how they are developed. They think you go to a lab and a month later have a vaccine but it’s not like that. It’s a naive view.”

Vaccine research moves far more slowly than most people realize, he said, observing that many shots that are administered today use decades-old vaccines. “If you look at the story of vaccines, we haven’t really had large numbers of new vaccines coming in to the market very frequently,” he said. “There are some but it’s not frequent.”



A lab worker at Migal in an undated photo released by the research institute. (Courtesy: Lior Journo)

He said that when new vaccines are developed, there are “long and difficult processes that are usually not without bumps in the road.” Often, the vaccine in development is not yet sufficiently safe or sufficiently effective, “and you’d go back to the drawing board and try to improve it.”

Chen Katz of Israel’s state-funded Migal Galilee Research Institute told The Times of Israel last week that a vaccine could get to human testing within the three-month time frame announced by the Science Ministry. Boston-based biotech firm Moderna expects to start human trials for its own vaccine next month.

Asked about claims that a breakthrough is imminent, Green said: “There are many companies and research teams that have been researching vaccines for years and they have to be optimistic or they wouldn’t be in business.”

**Coronavirus begins to rock technology industry amid government shutdowns worldwide; childcare a major obstacle for workers, but most feel prepared for extended quarantine**

By Luke Tress



Medical workers wear protective suits as a preventive measure against the coronavirus, as they arrive to test a patient with symptoms, Jerusalem, March 16, 2020. (Yonatan Sindel/ Flash90)

One-third of Israeli tech companies are planning on firing employees due to the coronavirus pandemic.

Five percent have already fired workers, and nearly two-thirds froze new hirings, said a survey by Israel's Viola investment group.

In an unofficial survey of the effects of the virus on the Israeli tech industry, the venture capital firm queried 135 chief financial officers and human resources staffers at tech companies.

The firms appear to be on better footing than other industries, with 55 percent saying they had not seen any effects from the pandemic, but a growing number are seeing an impact on their business. On March 11, only 5% had seen major business consequences due to the outbreak, but on March 15, 33% said they had.

As of Sunday, around half offered voluntary policies for working from home, and half had mandatory, or partial mandatory work-from-home policies. Smaller companies were more likely to offer voluntary policies, at 70%, while larger companies with over 150 employees ordered mandatory policies.

For Israeli tech companies with employees in the US, where government directives are less stringent, most US-based workers were also working from home, with only 16% working as usual.

Seventy-two percent of the firms said they felt well-prepared for an extended period of required work from home, and 59% said they had implemented policies, including virtual meetings, to ensure that employees were actually working from home.

Childcare is a significant challenge for the companies. The majority — 64% — said that they had allowed for shorter work days for parents since schools and daycare facilities in Israel were closed. Twenty-one percent are offering employees compensation for lost days due to childcare, and 9% are taking employee vacation days.

Twenty-one percent of the companies are planning on salary cuts, and 88% have frozen, or are planning to freeze new hires.

Only 11% have not changed their revenue models, a number that is likely to shrink further in the coming week.

Close to half have implemented marketing budget cuts, and one-third were planning to. Sixty-four percent have frozen, or were planning to freeze signings of new vendors or suppliers.

In one bright spot for the companies, 60% have taken advantage of the economic turbulence to buy shekels at a favorable exchange rate. The shekel has become weaker against the dollar in recent weeks. Most startups spend in shekels, but receive revenue and investments in dollars.

While the tech industry has for the most part weathered the storm so far, the virus outbreak in its early weeks rocked Israel's tourism and aviation industries.

Israel shuttered schools and most businesses over the past week, in a bid to stem the spread of the virus to avoid overwhelming the country's health infrastructure. The new measures are a blow to Israel's retail, food, and entertainment sectors. The construction industry is expected to remain largely unaffected.

The Bank of Israel and retail banks announced measures on Sunday to mitigate damage to the economy caused by the pandemic.

The bank will be buying government bonds and offering repo transactions to Israeli financial institutions, using government bonds as collateral. The bank did not specify the size of the planned transactions, only saying it would buy bonds "in the necessary quantities."

The move is intended to increase liquidity and decrease volatility in the markets, as spending is curtailed by closed businesses, limited movement, consumer fears and plummeting equities.

The bank said it was responding to high volatility in financial markets in Israel and abroad and that the measures will support price stability, government economic policy and Israel's financial system.

Retail banks will adjust policy to support the business sector and general public following a request from the Bank of Israel. The banks' newly announced regulatory leniencies are aimed in particular at small and mid-sized businesses, which rely heavily on bank credit.

The banks will offer a delay in mortgage payments for a few months, loans to small and mid-sized businesses that are seeing liquidity problems, expanded digital services for remote transactions, and courier services for customers in quarantine.

The banks are expected to announce additional measures in the coming days, including easing policies on loans, credit, remote transactions, and ATM cash supplies.

The Finance Ministry reportedly predicted that the partial shutdown would cost the economy some NIS 11 billion (\$3 billion) in six weeks.

Global markets and the Tel Aviv Stock Exchange plummeted on Monday, despite a massive rate cut from the US Federal Reserve on Sunday.

On Sunday, the Finance Ministry reportedly reached an agreement with employer and labor representatives to provide some NIS 3 billion (\$817 million) relief to businesses. Employers pledged to hold off on layoffs until after the Passover holiday in mid-April.

Following the shutdown announcement on Saturday, Israeli retailers immediately placed thousands of workers on unpaid leave. Restaurants will be allowed to continue offering take out and delivery. The construction sector is expected to remain largely unaffected by the directives.

The Health Ministry on Monday reported an additional 42 cases of the novel coronavirus in Israel, bringing the total number of confirmed infections up to 255.

The majority have light symptoms, while 13 are listed in moderate condition and five are seriously ill, the ministry said, adding that 8,325 tests have been carried out.

Viola, founded in 2000, manages over \$3 billion in assets and has worked with over 200 tech companies, it said.

By Maurizio Di Paolo Emilio

COVID-19 comes from a family of viruses associated with severe acute respiratory syndrome (SARS) and the common cold. Big data and predictive analysis, in combination with artificial intelligence and a variety of thermal sensors, are powerful tools to contain the spread of this epidemic and minimize its resulting deaths.

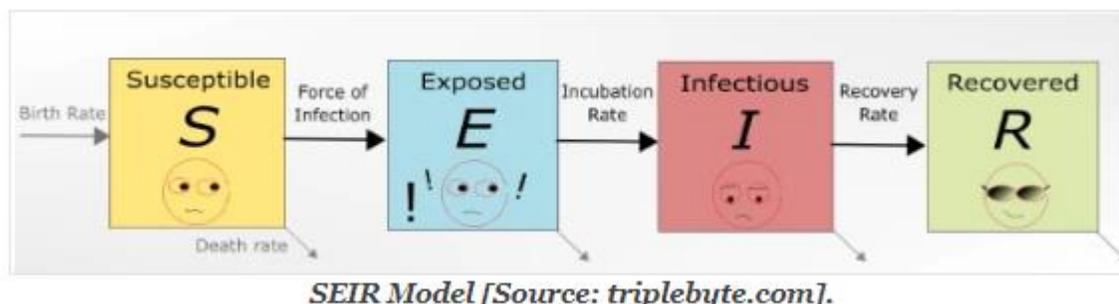
Given that testing for the virus is sporadic at best, the numbers of cases of infection are often very uncertain, and the real danger of the virus is questioned. A decisive contribution to support epidemiological experts could come from data analysis techniques.

Data analysis plays a fundamental role, as does mathematics, which, together with physics, allows us to have an in-depth understanding of the details of nature and how things are made. As in the past years, the pioneers of data science have made an incredible impact on the world where data and analysis have been used to drive significant change in the course of a spread of the disease. One of the first historical applications of data analysis was in 1852, during a cholera outbreak in London. John Snow, one of the first data-driven epidemiologists, was able to geospatially analyze the deaths that occurred in London and thus isolate the source of the disease. Relying on his analysis, authorities were able to target their interventions to rapidly check the spread of the epidemic.

### Let's evaluate the data

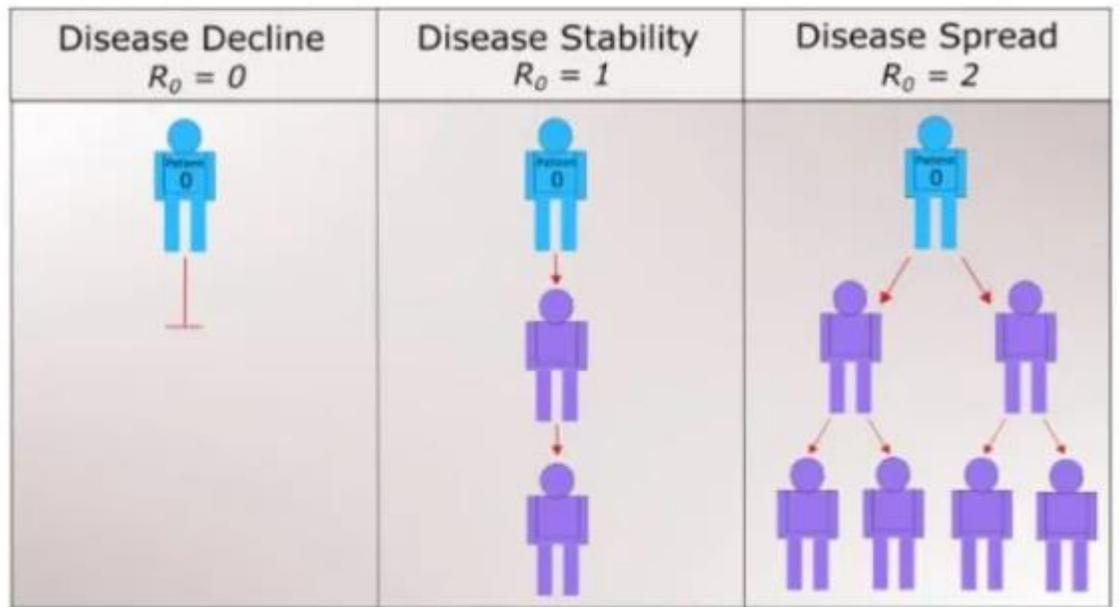
Running models through data analysis systems has proven to be able to approximate how trends might progress. An example is the SIR model; it is an epidemiological model that computes the theoretical number of people infected with a contagious illness in a closed population over time. The model uses coupled equations analyzing the number of susceptible people  $S(t)$ , number of people infected  $I(t)$ , and number of people who have recovered  $R(t)$ . One of the simplest SIR models is the Kermack-McKendrick model. The Kermack-McKendrick epidemic model is considered the foundation on which many other compartmental models were based. In this regard, I found Ettore Mariotti's analysis very interesting.

The idea is first of all to consider an island, our system, where people are not allowed in or out. Every individual can be in one of the following states at a given time: "Susceptible," "Infected" and "Recovered," hence the acronym SIR, because with a certain probability people who have never had the disease (S) can become ill and infected (I) for a certain period before they recover (R). In the case of CoVID-19, it is appropriate to extend the model with an additional state, "Exposed," to include people who have the virus but are not yet infectious (SEIR model).



This model considers two factors: the dynamics of the virus, and the interaction of individuals. The latter is very complex and would require technology like the one described in the previous paragraph. With all this, it is possible to define the  $R_0$  parameter, which represents the number of people that an infected person can potentially infect.

Let's suppose, for example, that person A is sick and that our system has an  $R_0=2$ . This would mean that A will infect two people. Those two people will, in turn, infect four people, who will infect another two people each (so  $4 * 2 = 8$ ) and so on. This highlights the fact that the spread of the disease is multiplicative rather than additive.  $R_0$  can capture three basic scenarios, as shown in Figure 2.



*R<sub>0</sub> basic scenarios [Source: triplebyte.com].*

The closure of schools, gyms, etc. decreases the social interaction of people, thus lowering  $R_0$ . The health system is limited, and it is very important to reduce this parameter below unity. If  $R_0 > 1$  the disease spreads, if  $R_0 < 1$ , the disease disappears. It is reasonable to expect governments to impose stricter constraints on people's mobility in an attempt to reduce  $R_0$ .

It is important to note that  $R_0$  measures the potential transmission of a disease, not the rate at which the disease spreads. Consider the ubiquitous nature of influenza viruses, which have an  $R_0$  of only about 1.3. A high  $R_0$  is a cause for concern, but not a cause for panic.

$R_0$  is an average, so it can be influenced by factors such as super-spreader events. A super-spreader is an infected individual who infects an unexpectedly large number of people. Super-spreader events occurred during SARS and MERS epidemics, and the current Covid-19. Such events are not necessarily a bad sign because they may indicate that fewer people are perpetuating an epidemic. Super-spreaders may also be easier to identify and contain, as their symptoms are likely to be more severe.

In short,  $R_0$  is a moving target. Tracking each case and the transmission of the disease is extremely difficult, so estimating  $R_0$  is complex and challenging. Estimates often change with the availability of new data.

Which technological solutions could slow down or end the spread of Covid-19 and get  $R_0$  under control? The use of AI, together with data from the GPS movement of mobile phones, allows creating analytical models to predict which neighborhoods are more likely to have future cases or those where urgent intervention is needed.

### Big data, AI and sensors

In case of an epidemic, clinical data can be highly variable in terms of quality and consistency. Complications of this sort include cases of false-positive patients. Big data and AI can be employed to check compliance with quarantine and machine learning can be used for drug research. These are just some of the solutions offered by new digital

technologies to face the coronavirus emergency. From Asia, there are many examples of interventions implemented through the use of digital technologies.

Drones equipped with smart scanners and cameras provide the ability to detect those who do not comply with quarantine measures and to check people's body temperature. The use of intelligent cameras in China and Taiwan has allowed intercepting people who are not wearing a mask but also to carry out a real-time thermal scan to detect possible cases of fever.

For example, the Chinese company SenseTime has developed a platform that scans people's faces even if they wear a mask, while Alibaba has developed a new AI-based coronavirus diagnosis system. SenseTime is a global company focused on developing AI technologies that advance the world's economies, society and humanity for a better tomorrow. It is also the world's most-funded AI pure-play with the highest valuation.

SenseTime has announced that its contactless temperature detection software has been implemented in subway stations, schools, and public centers in Beijing, Shanghai, and Shenzhen. Alibaba, meanwhile, has developed a new diagnosis system for the Covid-19 based on artificial intelligence that allows the detection of new coronavirus cases with an accuracy rate of up to 96 percent by means of computer tomographic scans (i.e., CT scans.)

Graphen, together with Columbia University, is trying to define the canonical form of each gene localization of the virus, and identify the exact variant(s). It uses its Ardi AI platform which mimics the functions of human brain to store these mutation data and visualize them. In the visualization at right, each red node represents a virus. Each green node represents a set of viruses possessing exactly the same genome sequence. A virus' information including location, gender, age, etc can be seen by clicking a red node.

Another useful tool for pandemic control is big data. In this period of emergency, it has been widely used to improve surveillance systems in order to map the spread of the virus.

The acquisition and processing of big data required the design of new methodologies and technologies for collection and analysis. In particular, we can distinguish four types or methodologies of big data analysis:

- Descriptive Analysis, i.e., the methodologies and technologies used to describe the current and past situation of business processes or business projects, representing in a synthetic and graphical way the performance indicators of the activity;
- Predictive Analysis, i.e., the data analysis tools that help to understand what could happen in the future using mathematical techniques such as regression and predictive models;
- Prescriptive Analysis, used to identify effective strategic and operational solutions;
- Automated Analysis, which includes the tools that allow the desired action to be implemented autonomously and in an automated manner and according to the result of the analyses that have been conducted.

Alibaba has also developed an app (Alipay Health Code), which, using the big data made available by the Chinese healthcare system, indicates who can or cannot access public spaces.

BlueDot, a Toronto-based startup that uses a platform built around artificial intelligence, has developed intelligent systems for the automatic monitoring of the spread of infectious diseases and their prediction. During the spread of SARS, the BlueDot platform had already had positive results. In December 2019, BlueDot also raised the alarm about the severity of the coronavirus syndrome, which proved to be correct. Among the tools used by BlueDot, there are also techniques that go under the name NLP (Natural Language Processing) that process people's languages and ways of expressing themselves.

Insilico Medicine is another company focused on disease prevention through artificial intelligence. Insilico Medicine is developing and applying next-generation artificial intelligence and deep learning approaches to every step of the drug discovery and drug development process. It is currently developing a technology that will inform doctors about

molecules that can fight the coronavirus. After recently analyzing molecules, the system of Insilico Medicine, is able to provide feedback on those that are suitable to fight the coronavirus. The start-up is currently developing a database of information in vaccine development projects.

Satellite analysis technologies have seen WeBank researchers use them to identify hot spots in steel mills that have provided important information on the industry's recovery.

In the early days of the epidemic, this analysis showed that steel production had dropped to a minimum of 29 percent of capacity. But by February 9, it had recovered to 76 percent. The researchers then looked at other types of production and commercial activities that use AI. One of the techniques was simply counting cars in large company car parks. This analysis showed that, as of February 10, Tesla car production in Shanghai had fully recovered, while tourism activities, such as Shanghai Disneyland, are still closed.



*Side by side satellite images from December 30, 2019 (left) and January 29th, 2020, show that steel industry activity is still down in China [Source: spectrum.ieee.org].*

By analyzing the GPS satellite data, it was possible to identify which people were commuting or not. The software then counted the number of commuters in each city and compared the number of commuters on a given day in 2019 and the corresponding date in 2020, starting on Chinese New Year. In both cases, Chinese New Year saw a huge drop in commuting, but unlike 2019, the number of people going to work did not recover after the holidays. As things slowly recovered, WeBank researchers calculated that by March 10, 2020, about 75 percent of the workforce had returned to work. Projecting from these curves, the researchers concluded that most Chinese

workers, with the exception of Wuhan, will return to work by the end of March. Economic growth in the first quarter, according to their study, will be 36 percent.

Those attempting to respond to the coronavirus challenge have an important ally in technology. With solutions that, tested in emergency phases, could become a standard in the future.



By Andrew Williams

The global automotive sector still remains in the early stages of Level 2 autonomy.

Estimates by Singapore technology market analysts Canalis finds that only 11% of new cars sold in Europe in Q4 2019 and 13% of new cars sold in the US in Q4 2019 had Level 2 driving systems installed. While not defined by SAE, so-called Level 2+ systems, including driver assistance and support features, are available in some new cars.

However, these are different to Level 3 systems where, once engaged, the system, not the human drives the vehicle under certain conditions until it requests the human to resume control. As Chris Jones, co-founder, vice-president and chief analyst at Canalis explains, the key technological challenges for the developers of Level 2/2+ systems are to produce systems capable of driving unconditionally, without the human's involvement.

“Precise vehicle location, HD maps, 360-degree sensing and driver state monitoring are all needed in Level 2+ systems. Level 3 is a challenge owing to the handover from system to human: will the human be ready to take over when required?” he says.

“Governments will only allow hands-off, eyes-off Level 3 systems to be launched and activated if they are completely satisfied with their reliability and robustness. Education is also key to ensure drivers, passengers and other road users know the capability of the systems. Some autonomous driving developers will skip Level 3 completely and focus on Level 4 systems, most likely in the form of city-based mobility-as-a-service vehicles,” he adds.

Elsewhere, Ilya Aristov, engagement manager at global IT consultancy outfit DataArt, thinks that a complex traffic environment and lack of 4G coverage outside big cities are among the biggest challenges that automotive vehicle developers are facing. In his view, Level 3 autonomy can only be achieved in big cities and in particular conditions.

“Right now, there are Level 3 cars from Audi, Honda, BMW, and others,” he says. “However, driving autonomy is limited to specific conditions. To refine Level 3, I think we should have more accurate maps, together with a stable GPS signal, to be 100% sure where the car is.”

Aristov also argues the industry should place a strong focus on making the life of pedestrians safe with the help of all

sensors onboard and calls for all automotive manufacturers to join forces to improve the decision-making capabilities of the car with the help of machine learning and artificial intelligence.

“If we’re talking about Level 4, cars absolutely have to make us confident that they can work well at Level 3. It’d be great to enjoy a car ride if I were 100% sure that the vehicle will stop when needed, and my family, or whoever is in and around my car, is safe. It’s more about trust and time rather than technologies. I would also keep in mind the joy of controlling the car and deciding when to accelerate or hit a brake,” he says.

### **Role of AI**

In Jones’ view, the emergence of Level 2+ assistance systems through 2020 will further delay the launch of Level 3 autonomous systems, or even stop their progress completely. Also Level 4 robo-taxis trials and deployments in cities around the world will also impact the progress of Level 3 systems. He observes that next-generation Level 2+ systems need precise centimeter-level accuracy, vehicle location, HD maps with road-ahead awareness of incidents and 360-degree vehicle surround sensing from radars, cameras, sonar, LiDAR and software, as well as camera and sensor-based driver state monitoring and 4G/5G-based V2X communication. “Level 4 vehicles will include all this technology, plus there will be a focus on comfort, convenience and connectivity for the passengers, backed up by a robust MaaS platform,” he says.

Looking ahead, he predicts that autonomous driving systems will become more experienced drivers, that more types of vehicle will benefit from the technology, and that urban mobility solutions, V2X and 5G will be key elements of smart city transportation initiatives. In terms of wireless connectivity, he also observes that vehicles will ‘visually and audibly communicate with other road users and their passengers. AI will also be widely used to help the system drive but will also improve the user and passenger experience.

“The sensors will get better and become less expensive, which will be key in producing Level 2+ systems for mass market vehicles, Level 4 vehicles for individual ownership and robo-taxis for MaaS providers to run profitable platforms,” he says. “The MaaS platforms must offer enough clean, well maintained, well equipped, safe, zero-emission vehicles to ensure passengers must only wait a few minutes for a ride. With urbanization continuing, successful MaaS solutions will be key to reducing car ownership, easing congestion, preventing road fatalities and serious injuries and improving the environment.”

Meanwhile, Aristov cites computer vision and machine learning as key technologies for Level 3 and points out they should not only work outside the car but also check the driver’s condition inside the car. “As for Level 4, I think it’s fault tolerance and security. Machine learning algorithms will play the key role. Cars have enough sensors, and data quality grows steadily. What we are missing nowadays is the right behavior for self-driving cars, being predictable for all the traffic participants,” he says.

“I’d add security topics here, some new protocol development, or just providing enough confidence that the car won’t be easily hacked. I’m also very interested to see 5G network development pushing the boundaries of wired connectivity. Let’s see what we can get when the coverage is sufficient,” he adds.

**Civilizations have recognized copper's antimicrobial properties for centuries. It's time to bring the material back.**



By Mark Wilson

In China, it was called “qi,” the symbol for health. In Egypt it was called “ankh,” the symbol for eternal life. For the Phoenicians, the reference was synonymous with Aphrodite—the goddess of love and beauty.

These ancient civilizations were referring to copper, a material that cultures across the globe have recognized as vital to our health for more than 5,000 years. When influenzas, bacteria like *E. coli*, superbugs like MRSA, or even coronaviruses land on most hard surfaces, they can live for up to four to five days. But when they land on copper, and copper alloys like brass, they die within minutes. “We’ve seen viruses just blow apart,” says Bill Keevil, professor of environmental healthcare at the University of Southampton. “They land on copper and it just degrades them.”

No wonder that in India, people have been drinking out of copper cups for millennia. Even here in the United States, a copper line brings in your drinking water. Copper is a natural, passive, antimicrobial material. It can self-sterilize its surface without the need for electricity or bleach.

Copper boomed during the Industrial Revolution as a material for objects, fixtures, and buildings. Copper is still widely used in power networks—the copper market is, in fact, growing because the material is such an effective conductor. But the material has been pushed out of many building applications by a wave of new materials from the 20th century. Plastics, tempered glass, aluminum, and stainless steel are the materials of modernity—used for everything from architecture to Apple products. Brass door knobs and handrails went out of style as architects and designers opted for sleeker-looking (and often cheaper) materials.

Now Keevil believes it’s time to bring copper back in public spaces, and hospitals in particular. In the face of an unavoidable future full of global pandemics, we should be using copper in healthcare, public transit, and even our homes. And while it’s too late to stop COVID-19, it’s not too early to think about our next pandemic.

### **The benefits of copper, quantified**

We should have seen it coming, and in reality, someone did.

In 1983, medical researcher Phyllis J. Kuhn wrote the first critique of the disappearance of copper she'd noticed in hospitals. During a training exercise on hygiene at Hamot Medical center in Pittsburgh, students swabbed various surfaces around the hospital, including toilets bowls and door knobs. She noticed the toilets were clean of microbes, while some of the fixtures were particularly dirty and grew dangerous bacteria when allowed to multiply on agar plates.

“Sleek and shining stainless steel doorknobs and push plates look reassuringly clean on a hospital door. By contrast, doorknobs and push plates of tarnished brass look dirty and contaminating,” she wrote at the time. “But even when tarnished, brass—an alloy typically of 67% copper and 33% zinc—[kills bacteria], while stainless steel—about 88% iron and 12% chromium—does little to impede bacterial growth.”

Ultimately, she wrapped her paper up with a simple enough conclusion for the entire healthcare system to follow. “If your hospital is being renovated, try to retain old brass hardware or have it repeated; if you have stainless steel hardware, make certain that it is disinfected daily, especially in critical-care areas.”

Decades later, and admittedly with funding from the Copper Development Association (a copper industry trade group), Keevil has pushed Kuhn's research further. Working in his lab with some of the most feared pathogens in the world, he has demonstrated that not only does copper kill bacteria efficiently; it also kills viruses. (In 2015, he even demonstrated this phenomenon with a precursor to COVID-19, coronavirus 229E).

In Keevil's work, he dips a plate of copper into alcohol to sterilize it. Then he dips it into acetone to get rid of any extraneous oils. Then he drops a bit of pathogen onto the surface. In moments it's dry. The sample sits for anywhere from a few minutes to a few days. Then he shakes it in a box full of glass beads and a liquid. The beads scrape off bacteria and viruses into the liquid, and the liquid can be sampled to detect their presence. In other cases, he has developed microscopy methods which allow him to watch—and record—a pathogen being destroyed by copper the moment it hits the surface.

The effect looks like magic, he says, but at this point, the phenomena at play is well-understood science. When a virus or bacteria strikes the plate, it's flooded with copper ions. Those ions penetrate cells and viruses like bullets. The copper doesn't just kill these pathogens; it destroys them, right down to the nucleic acids, or reproductive blueprints, inside.

“There's no chance of mutation [or evolution] because all the genes are being destroyed,” says Keevil. “That's one of the real benefits of copper.” In other words, using copper doesn't come with the risk of, say, over-prescribing antibiotics. It's just a good idea.

### **In real-world testing, copper proves its worth**

Outside of the lab, other researchers have tracked whether copper makes a difference when used in real-life medical contexts—which includes hospital door knobs for certain, but also places like hospital beds, guest-chair armrests, and even IV stands.

In 2015, researchers working on a Department of Defense grant compared infection rates at three hospitals, and found that when copper alloys were used in three hospitals, it reduced infection rates by 58%. A similar study was done in 2016 inside a pediatric intensive care unit, which charted a similarly impressive reduction in infection rate.

But what about expense? Copper is always more expensive than plastic or aluminum, and often a pricier alternative to steel. But given that hospital-borne infections are costing the healthcare system as much as \$45 billion a year—not to mention killing as many as 90,000 people—the copper upgrade cost is negligible by comparison.

Keevil, who no longer receives funding from the copper industry, believes the responsibility falls to architects to choose copper in new building projects. Copper was the first (and so far it is the last) antimicrobial metal surface approved by the EPA. (Companies in the silver industry tried and failed to claim it was antimicrobial, which actually

led to an EPA fine.) Copper industry groups have registered over 400 copper alloys with the EPA to date. “We’ve shown copper-nickel is just as good as brass at killing bacteria and viruses,” he says. And copper nickel doesn’t need to look like an old trumpet; it’s indistinguishable from stainless steel.

As for the rest of the world’s buildings that haven’t been updated to rip out the old copper fixtures, Keevil has a piece of advice: “Don’t remove them, whatever you do. These are the best things you’ve got.”

By Eliza Haverstock

Long grocery-store lines snake down sidewalks. Nothing sits on the shelves where toilet paper should be. Stocks are relentlessly plummeting, and many cities and states have shuttered schools, restaurants and events for the foreseeable future.

With the constant stream of information about escalating COVID-19 infection rates permeating headlines, the world is now not only grappling with a viral pandemic, but also the toll it's taking on mental health. But startups in the space are rapidly scaling to meet the demand, and those that offer virtual treatments are particularly important as social distancing measures become the moral and, for some, government-mandated imperative. More coronavirus news: Continuing coverage from PitchBook.

On Monday, popular meditation app Headspace unveiled free subscriptions to healthcare professionals working in public health settings through 2020—a service that typically runs about \$70 for a full year. Additionally, the Santa Monica, Calif.-based startup, which last month raised a \$93 million Series C led by Blisce, has created a free meditation collection dubbed "Weathering the storm" that's available for any user.

Since Friday, Headspace has seen double the average amount of inbound requests from members looking for content to help them through pandemic-related stress, and a 100% increase in corporate clients seeking support for their employees' mental wellbeing, according to Megan Jones Bell, the company's chief science officer.

Monday brought even more announcements from the mental health startup space. Bay Area-based Lyra Health, which works with employers to offer virtual and in-person mental health treatments, said it landed Starbucks as a client.

Starting Apr. 6, Starbucks will offer up to 20 annual therapy sessions to its 220,000 US employees and their dependents through Lyra's network, the companies said. The coffee juggernaut said on Sunday it would limit hours, close some shops and remove in-store seating at locations in the US and Canada for at least two weeks in an effort to slow the spread of the coronavirus.

Seattle-based Ginger, which also offers virtual chat and video therapy through employers, has seen therapy and psychiatry sessions increase about 16% recently—up 25% based on its quarter-to-date average, according to CEO Russell Glass. The startup, which recently raised a \$35 million Series C round led by WP Global Partners, is considering removing its standard 12-month contract length in light of today's permeating coronavirus anxieties, he said.

But when weighing new offerings, Glass acknowledged the tricky marketing situation that his industry faces right now.

"Some of what we're talking about is ... 'What are the plans?' 'How can we help as many as possible through this?' That we're doing it all for the right reasons," Glass said. "Obviously we're a business and we're trying to grow and be profitable. But we also want to make sure you balance that with providing great care."

Startups that facilitate in-person therapy visits are also seeing increased business, despite social distancing and self-quarantine measures.

Take Reflect, for example, a small San Francisco-based startup that uses an algorithm to connect people with therapists in the Bay Area and Los Angeles. The largely bootstrapped company, which has raised about \$1 million in

funding to date and is on pace to be cash flow positive this year, has seen double-digit growth in the past month and an uptick in demand since the first mentions of the coronavirus in the news, according to founder and CEO Jonathan TranPham. Reflect is also working with its provider network to offer virtual visits as necessary, he said.

"I think mental health is one of those industries that will weather market volatility or a recession, because at the end of the day people need that support that we can provide," TranPham said.

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## *Virus Begins Separating Strong Startups From Weak*

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By Kate Clark, Amir Efrati, Zoe Bernard and Kevin Dugan

While it will take months to understand the full impact of the coronavirus on the startup economy, evidence of its grim toll is already beginning to mount.

Take Service Technologies, a Los Angeles–based online travel startup that went out of business abruptly on Monday. That followed the failure of a recent effort to raise a new round of capital, amid new restrictions companies have imposed on employee travel. In an interview, Michael Schneider, Service’s CEO, said he immediately began negotiating a deal with Enterprise Holdings for the car rental firm to acquire Service’s staff and perhaps some of its assets. But last Friday, Enterprise called him to say the deal was off because of the disruption to business travel.

On Monday, Schneider sent a note to customers, including Microsoft and Facebook, saying that Service—which helps companies get refunds from airlines for delayed and canceled flights—would shut down. “It’s a very odd feeling,” Schneider said. “You’re about to lose your investors’ money, which is not great. And customers have paid for yearly subscriptions. But overwhelmingly we have gotten very supportive [responses] from customers thanking us for the money we got them [from airlines].”

A spokeswoman for Enterprise didn’t immediately have a comment.

Service’s demise highlights the economic side effects of the current public health crisis, venture capitalists and entrepreneurs say. The stronger companies will be fine, many say. The runts of the litter—companies with growth problems, uncertain prospects for turning profits and other business issues—will perish. Some of them will likely blame the outbreak for their demise even when the root causes began earlier.

Another outcome: As valuations of the more promising startups fall, venture capitalists could end up owning much more of them, as they have in past downturns. Business categories that are shining in the current crisis, such as software for enabling remote work, are seeing a groundswell in investor interest.

Still, investors say they are seeing sweeping changes in startup financing since the outbreak worsened. “Every single deal is either being repriced or rethought or not happening,” said Arjun Sethi, a venture capitalist with Tribe Capital. “Either companies are raising at lower valuations or [they are] laying people off.”

One of those companies is Panda, a small consumer app that allows people to star in television shows with their friends. Last Friday, Panda laid off nearly its entire staff of six employees, and it plans to pivot in a new direction, said Daniel Singer, its CEO and founder. Singer said the company—which has already raised about \$3.2 million—was planning on raising a new round of financing this month, but investors were far more interested in software as a service companies with cash flow than in a riskier consumer company.

“Everything is slowing down tremendously. The couple of investors I spoke to said, ‘This will get a lot worse before it gets better,’” he said. “You can’t run a fundraising process when so much of it is relationship building. It’s never the same over Zoom calls. Whether they say it or not, people are going to be holding onto cash more and being pickier.”

Later-stage investments, particularly those around Series D and E financings, have come to a standstill in the last two weeks, with investors from Kuwait and Saudi Arabia backing out of \$15 million or larger deals, said Omeed Malik, founder and CEO of merchant bank Farvahar Partners, who has seen such deals fall apart.

“The current pandemic has illustrated the global interconnectedness not only of human interaction but also [of] capital flows,” Malik said. “Coronavirus-related headwinds faced by countries in the Middle East or Asia have prevented local investors there from consummating deals in U.S.-based venture-backed companies.”

Then again, it all depends on the company that’s raising money. On Monday afternoon, HashiCorp, a buzzy cloud software startup, announced that it has raised a \$175 million Series E financing led by Franklin Templeton at a valuation of \$5.1 billion, up from a \$1.8 billion valuation in November 2018.

Some venture capitalists described the impact of coronavirus on the startup investing climate so far as a muted one. Bradley Tusk, co-founder of Tusk Ventures, a venture capital firm focused on startups in highly regulated markets, said he received a recent request from a portfolio company in need of emergency funding, but that company had already been failing.

“The portfolio companies that are performing really well have also handled this really well, and the ones that have not been performing as well in general also seem more paralyzed at this moment,” said Tusk, who said he didn’t provide the emergency funding to the troubled startup in his portfolio.

While economic downturns can ravage many startups, they also offer silver linings for venture capitalists that manage to get bigger pieces of the survivors as lofty company valuations fall back to earth. “The asset class does really well during a financial crisis. I think the reason for that is [that] valuations come down so you end up owning more of the company for less capital deployed,” said Jack Chapman, a venture capitalist with Alpha Bridge Partners.

Other methods of raising capital, such as debt financing, can also see upticks during downturns. David Spreng, CEO of Runway Growth Capital, which lends capital to companies, said that his “phone is ringing off the hook” recently from startups looking for loans. While debt financing has downsides—it doesn’t offer the industry connections that VCs can provide and companies still have to repay the loans if they fail—they allow startups to quickly raise cash with far less dilution to their stakes.

“The tectonic shift away from growth at any cost to finding a path of profitability was definitely already happening, and I think this will just accelerate that,” he said. “The problem, or maybe the opportunity for us but the challenge for entrepreneurs, is...the coronavirus is going to cause VCs to get even more cautious with where they put their money.”

And while the pullback in consumer and business spending will hit some sectors hard—the outlook for travel companies like Service is particularly dire—others will thrive. Jason Green, a general partner at venture firm Emergence Capital, expects a boom in remote work software, a category that has received outside attention in the past weeks as many large companies make their employees work from home.

In a recent blog post, Green pointed out that enterprise software companies were more resilient in the wake of the 2008 financial crisis than other sectors. And with the popularity of business tools Zoom and Slack during the current crisis, “We’re already starting to see hints that the current crisis could usher in a new era of remote work software,” said Green, whose firm invested in Zoom.

Meanwhile, Catharine Dockery, founder of Vice Ventures, said the startups in her portfolio—she only invests in “sin” startups that most venture capitalists are squeamish about, including Maude, a sex toy maker—are also proving resilient as people take to their homes. “All of my companies are doing exceptionally well because people are stuck at home—they are ordering alcohol, nicotine and sex toys online,” she said.

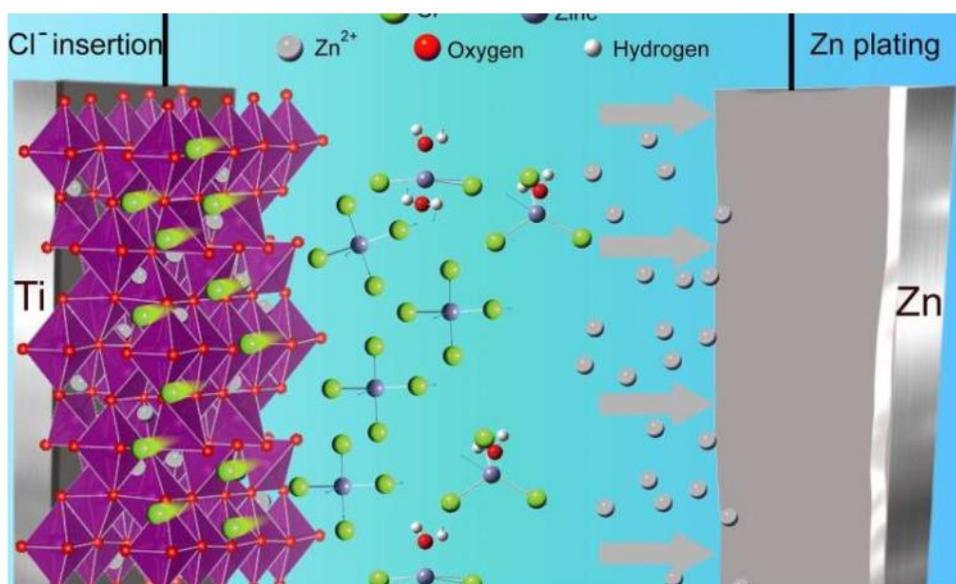
Still, entrepreneurs said that startups are beginning to operate much more cautiously. Greg Hayes, CEO and co-founder of Branch Furniture, an online office furniture retailer, said he has been tracking the progress of the

coronavirus for some time because the company manufactures many of its products in China, where the outbreak originated.

“It’s amazing to me how communicative our investors have been about it, very openly discussing with us that they are happy with our business and if we need to top off the coffers a little bit that they’re there for us,” he said.

“I think a lot of companies have learned a lot of lessons over the last six months watching what happened to WeWork and Casper and other companies blowing through cash,” Hayes added. “A lot of startups have very quickly started to operate more conservatively. I think this will be a huge wake-up call for companies in terms of conserving capital.”

Published by Oregon State University



Credit: Oregon State University

A serendipitous discovery during research into batteries at Oregon State University holds major implications for inventing new materials with a vast range of scientific and commercial applications, the study's corresponding author says.

Many of science's most significant challenges trace to the limits of known available materials, but a phenomenon named "counter-ion insertion" by OSU College of Science researchers opens the door to "a great number of new solids with values transcending different

disciplines well beyond battery chemistries," said Xiulei (David) Ji, associate professor of chemistry. "This is the beginning point of a whole new field."

For example, batteries designed using this construction show remarkable potential for low-cost energy storage, Ji said. Compared to the lithium ion batteries used to power cellphones, laptops, medical equipment, power tools, vehicles and more, they're safer and more environmentally friendly and can be more cost effective.

Findings were just published in Carbon Energy.

Researching ion-storage chemistry in solids—specifically, looking at anions rather than cations to store energy—Ji and Ph.D. student Heng Jiang tested the manganese oxide  $Mn_3O_4$  as an electrode in a zinc ion battery.

The test of hosting zinc ions was unsuccessful but instead delivered an unprecedented chloride battery electrode, showing that anion-hosting batteries work better after cations are trapped in the electrodes.

"We expect this marks the inauguration of counter-ion insertion as a generic electrosynthesis methodology for materials design," Ji said. "Battery discharge or charge processes can be powerful synthesis tools, and the process where an electrode fails to deliver desirable properties in one type of battery can be the exact electrosynthesis needed for creating an excellent electrode for another type of battery."

There are many different types of batteries but they all work the same basic way and contain the same basic components: Two electrodes—the anode, from which electrons flow out into an external circuit, and the cathode, which acquires electrons from the external circuit—and the electrolyte, the chemical medium that separates the electrodes and allows the flow of ions between them.

Most batteries, Ji explains, store electricity via cations. A cation is an element or a molecule that is missing one or more electrons and is positively charged. An anion, which can also be used to store electricity, is an element or molecule that has one or more extra electrons and is negatively charged.

"There are fewer known materials that can store anions reversibly than for storing cations," Ji said. "As an example for cation storage, the reversible insertion of lithium ions led to the technology of lithium ion batteries."

Reversible means the battery can be recharged, like the one in a cellphone.

Lithium ion batteries work well because the cation being stored is small and light. For anion storage, the desirable anions are halides—a single halogen atom with one extra electron. Iodine, bromine, chlorine, and fluorine are the halogens, and their anions are known as iodide, bromide, chloride and fluoride.

"Chloride is relatively light and small compared to other kinds of anions that have been tried, bulky polyatomic ions like nitrate, sulfate and hexafluorophosphate, which tend to gradually warp the electrode structures," Ji said.

In this study, the  $Mn_3O_4$  cathode reversibly stored chloride with great effectiveness after zinc cations ( $Zn^{2+}$ ) were trapped within the cathode's chemical structure.

"The trapped cations transform  $Mn_3O_4$  such that the reversible storage of the chloride becomes much more viable," Ji said. "The zinc and chloride are counter-ions to each other, which causes favorable interactions leading to unprecedented properties in capacity, operation potential and cycling life. The anion-hosting cathode works with a zinc metal anode in a full-cell dual-ion battery with an aqueous electrolyte."

Dual-ion batteries have both cations and anions involved in the battery's electrochemical reduction-oxidation, or redox, reaction.

Batteries of the dual-ion variety that use aqueous electrolytes—electrolytes containing water—have "remarkable potential for low-cost energy storage," Ji said. Compared to lithium ion batteries, they're safer, more environmentally friendly and can be more cost effective.

"We demonstrated this patent-pending battery chemistry in prototype pouch cells, which is close to commercialization," he said. "Even more important, counter-ion insertion looks like a methodology with important electrosynthesis implications across the whole spectrum of materials science. The knowledge of counter-ion insertion will potentially grow exponentially over the next three to five years with many new materials to be invented."

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**More information:** Heng Jiang et al. Counter-ion insertion of chloride in  $Mn_3O_4$  as cathode for dual-ion batteries: A new mechanism of electrosynthesis for reversible anion storage, *Carbon Energy* (2020). DOI: [10.1002/cey2.37](https://doi.org/10.1002/cey2.37)

**Which automakers are best poised to succeed in the future of mobility? That's the question prompting the appearance of many of the world's top automotive manufacturers – including Ford, Honda and BMW – at major technology shows like CES 2020 in Las Vegas.**

Article from Omron Automation

As third-time presenters at the show, we embraced the opportunity to learn more about automotive companies' bold visions of the future and consider the ways in which our automation technologies can help these visions become reality.

Let's take a look at a few of the most prominent near-future trends on display at CES 2020.

### **Perfecting the in-vehicle experience**

Today's consumers no longer see cars as just a means of transportation or a status symbol. The "in-vehicle experience" – including blind spot monitoring, connectivity, advanced automotive seat design and other aspects that impact the way drivers and passengers experience the vehicle – is gaining momentum and will continue to do so as autonomous driving takes hold.

BMW took this trend to the maximum with a new design that turns the interior car space into a luxurious, mobile roomette for one driver and one passenger – essentially, a purpose-built vehicle for travel with a chauffeur. The passenger can enjoy a large, cozy seat with a footrest, a screen that flips down from the ceiling and a "personal sound zone" for added privacy.

Other in-vehicle experience demos at CES included GM's integration of the Alexa voice-controlled virtual assistant from Amazon into a new Cadillac CT5 and Honda's new "Smartphone as Brain" technology that lets people safely use their phones while driving.

### **Bringing electric vehicles to the mass market**

As concerns about the environment take front seat, many automakers are working quickly to develop electric vehicles that the average consumer will find appealing. For cleaner technologies to gain traction, they need to be affordable, reliable, and in no way inferior to other, less-sustainable options.

Electric vehicles on display at CES 2020 included Ford's 2021 Mustang Mach-E crossover, Fisker's Ocean all-electric crossover, and Nissan's Ariya electric crossover concept. Each of these vehicles is expected to have a 300-mile battery range, and the Ariya can go from 0 to 60 mph in less than five seconds.

### **Preparing for a multi-mode ecosystem of autonomous vehicles**

Things got even more interesting as automotive manufacturers began to imagine the future of mobility not just as a collection of individual cars, but rather as a coordinated ecosystem of purpose-built vehicles that work together autonomously to bring people to their destinations, make deliveries, and even provide a mobile workstation just for kicks.

Perhaps the most elaborate and far-reaching depiction of the future came from Toyota, which unveiled its Mobility Services Platform (MSPF) that looks toward the next 100 years and beyond. Toyota envisions a versatile suite of flexible vehicles that function as a whole to provide a fully-connected mobility solution for any need that may arise.

Not to be outdone, Hyundai let its vision soar with a flying vehicle concept that could evolve into a system of flying taxis. It also showcased a flexible vehicle prototype incorporating some elements of autonomous driving.

### **What this all means for manufacturing**

Given all the demands for versatility and customization, it goes without saying that flexibility will also be paramount on the factory floor. In order to provide drivers with the in-vehicle experience of their choice, automakers must be ready to produce a variety of cars in a way that minimizes downtime from changeovers.

Manufacturing flexibility, in turn, creates a need for better traceability. Flexible systems are inherently more complex than production lines dedicated to a single product, and it's essential to completely and accurately track all vehicle components. Traceability systems using barcode readers, RFID technology or machine vision (or a combination of these) will be paramount.

The added complexity of next-generation vehicles will create an even greater need for ensuring the viability of each part and the correct placement of components during assembly. Verification systems for labels and direct part marks will only grow in importance as the cars of the future take on more capabilities to enhance the in-vehicle experience.

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*The content & opinion in this article are the author's and do not necessarily represent the views of Chambiz*

By Eugene Demaitre



A geometric approach to mobile robot navigation and obstacle avoidance may be sufficient for environments such as warehouses, but it might not be enough for dynamic settings outdoors. Researchers at the University of California, Berkeley, said they have developed BADGR, “an end-to-end, learning-based mobile robot navigation system that can be trained with self-supervised, off-policy data gathered in real-world environments, without any simulation or human supervision.”

Field robots must be able to find their way through tall grass, across bumpy ground, or in areas without the lanes typical of indoor facilities or roads. The conventional approach is to use computer vision and train models based on semantic labeling.

“Most mobile robots think purely in terms of geometry; they detect where obstacles are, and plan paths around these perceived obstacles in order to reach the goal,” wrote UC Berkeley researcher Gregory Kahn in a blog post. “This purely geometric view of the world is insufficient for many navigation problems.”

However, a robot could autonomously learn about features in its environment “using raw visual perception and without human-provided labels or geometric maps,” said the study’s authors, Kahn, Pieter Abbeel, and Sergey Levine. They explored how a robot could use its experiences to develop a predictive model.

The research was supported by the U.S. Army Research Lab’s Distributed and Collaborative Intelligent Systems and Technology Collaborative Research Alliance (DCIST CRA), the National Science Foundation (NSF), the Defense

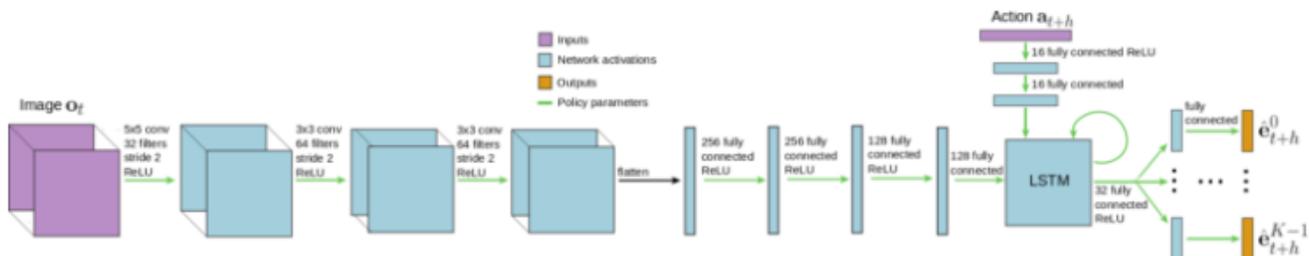
Advanced Research Projects Agency (DARPA) Assured Autonomy Program, and Berkeley DeepDrive. Kahn was supported by an NSF graduate research fellowship.

## Building BADGR

The team at Berkeley AI Research Lab (BAIR) developed the Berkeley Autonomous Driving Ground Robot, or BADGR, to gather data from real-world environments and essentially train itself how to avoid obstacles. It was based on a Clearpath Jackal mobile robot and included a six-degree-of-freedom inertial measurement unit sensor, GPS, a 2D lidar sensor, and an NVIDIA Jetson TX2 processor.

Rather than retrain policies with recently gathered data, or on-policy data collection, the Berkeley researchers decided to use off-policy algorithms, which can train policies using data gathered by any control policy. BADGR also used a time-correlated, random-walk control policy so that the robot would not just drive in a straight line.

BADGR autonomously collected and labeled data, trained an image-based predictive neural network model, and used that model to plan and execute paths based on experience, said Kahn.



*The neural network predictive model at the core of BADGR. Source: Greg Kahn, BAIR*

## BAIR gets results

The researchers tested BADGR at the Berkeley Richmond Field Station Environmental site. With only 42 hours of autonomously collected data, BADGR outperformed Simultaneous Localization and Mapping (SLAM) approaches, said the BAIR team. It did so with less data than other navigation methods, it wrote.

We performed our evaluation in a real-world outdoor environment consisting of both urban and off-road terrain,” stated the researchers. “BADGR autonomously gathered 34 hours of data in the urban terrain and eight hours in the off-road terrain. Although the amount of data gathered may seem significant, the total dataset consisted of 720,000 off-policy data points, which is smaller than currently used datasets in computer vision and significantly smaller than the number of samples often used by deep reinforcement learning algorithms.”

For instance, a SLAM plus planner-based system failed to avoid bumpy grass, while BADGR learned to stick to concrete paths. The mobile robot also avoided collisions in off-road environments more often.

BAIR’s experiments also found that BADGR’s performance improved over time, as it picked a more direct route to a target. The system was also able to generalize its lessons to new environments.

“The key insight behind BADGR is that by autonomously learning from experience directly in the real world, BADGR can learn about navigational affordances, improve as it gathers more data, and generalize to unseen environments,” Kahn wrote.

The researchers acknowledged that the mobile robot still required human assistance, such as when it flipped over, but they noted that BADGR needed less data than other approaches. They said more work remains to be done with remote support, testing around moving objects and people, and gathering more data.

“We believe that solving these and other challenges is crucial for enabling robot learning platforms to learn and act in the real world, and that BADGR is a promising step towards this goal,” the team said.



*BADGR successfully reached its goal while avoiding collisions and bumpy terrain, unlike a geometry-based policy. Source: Greg Kahn, BAIR*



*BADGR's path planning improved as it gathered more data. Source: Greg Kahn, BAIR*

**By adding oxygen or hydrogen to a thin-film oxide, researchers could reversibly change its thermal conductivity to higher and lower values than nominal, perhaps eventually leading to voltage-controlled, tunable thermal paths.**

By Bill Schweber

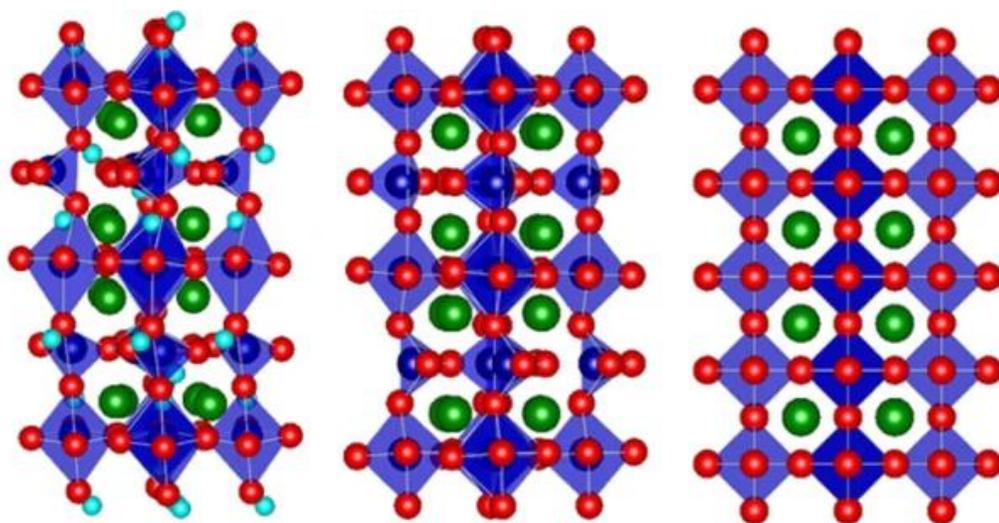
While we have materials and components with controllable, adjustable electronic and magnetic properties, one related characteristic has thus far eluded in-use adjustment. Thermal conductivity is generally considered “invariant” and set by the specific materials used and the construction of the associated device or component.

But this last barrier may be falling: An MIT team working with Brookhaven National Laboratory has developed what they indicate is the first material with voltage-controllable thermal conductivity, in work supported by the National Science Foundation and the U.S. Department of Energy. Their paper published in *Nature Materials* with the somewhat obscuring title “Bi-directional tuning of thermal transport in SrCoOx with electrochemically induced phase transitions” (plus Supplementary Information) describes what they used and how they did it, along with the underlying thermal and materials science.

Applications for such adjustable, controlled thermal conductivity could include maintaining a constant component temperature by thermally modulating the heat-flow path. Another could be to build a thermal-storage container that insulates and retains the heat as it’s captured, but can be switched to a highly conductive state when that heat is needed.

The traditional thermal-conductivity premise is that atoms inserted into a material’s lattice act as a source of scattering for thermal carriers, and so can only reduce thermal conductivity. Instead, the project has shown that electrochemical control of oxygen and proton concentration in an oxide provides a new ability to bidirectionally control thermal conductivity.

Of course, devising an actual technique for bidirectional control of thermal conductivity isn’t an obvious undertaking. To make it happen, they used a strontium cobalt oxide (SCO), which can be fabricated as a thin film (see figure). By electrochemically oxygenating the brownmillerite (designated SrCoO<sub>2.5</sub>) to the perovskite (SrCoO<sub>3-δ</sub>), thermal conductivity increased by a factor of 2.5; in contrast, adding hydrogen to form hydrogenated SrCoO<sub>2.5</sub> effectively reduces the thermal conductivity by a factor of four.



Strontium cobalt oxide (SCO) naturally occurs in an atomic configuration called brownmillerite (center). When oxygen ions are added to it (right), it becomes more orderly and with increased thermal conductivity. But when hydrogen ions are added (left), it becomes less orderly and has less such conductivity. (Source: MIT)

In short, adding oxygen to SCO increased its thermal conductivity while adding hydrogen had the reverse

effect. The overall tuning of thermal conductivity was across a nearly  $10 \pm 4$ -fold range at room temperature, and the variation was greater at lower temperatures.

Thermal conductivity was assessed using time-domain thermoreflectance (TDTR), a technique that can measure its values over many orders of magnitude from a high-end value of  $\sim 2000$  W/m-K (seen with some diamond and graphite structures) down to as low as  $0.03$  W/m-K (disordered tungsten diselenide or WSe<sub>2</sub> thin films).

How do you add this oxygen or hydrogen as needed? The material is immersed in an ionic liquid (essentially a liquid salt) or put in contact with a solid electrolyte that supplies either negative oxygen ions or positive hydrogen ions (protons) into the material when the voltage is turned on. In the liquid-electrolyte case, hydrolysis of water from the surrounding air is the source of oxygen and hydrogen.

### **Piecing Together the Physics Puzzle**

The underlying physics mechanism was puzzling at first. It was assumed that adding the extra atoms or ions (atoms stripped of some electrons, or with excess electrons), would make conductivity worse due to the greater internal disorder, as thermal energy (heat) tends to be scattered and dissipated by more-irregular atomic structures. However, inserting oxygen ions into the structure of the brownmillerite SCO transforms it into a perovskite structure, which actually has an even more highly ordered structure than the original.

MIT Professor and project leader Bilge Yildiz noted, “It goes from a low-symmetry structure to a high-symmetry one. It also reduces the amount of so-called oxygen vacancy defect sites. These together lead to its higher heat conduction.” The oxygenation/hydrogenation process introduced more order or disorder, respectively, and thus affected thermal conductivity.

Of course, using liquids to adjust the oxygen/hydrogen injection isn’t practical for most systems. Prof. Yildiz pointed out that “what we have shown here is really a demonstration of the concept,” adding that the need for a liquid electrolyte medium for hydrogenation and oxygenation makes this version of the system “not easily applicable to an all-solid-state device.” However, she added that “we know there are solid-state electrolyte materials that, in theory, could replace the liquids” and further investigation is needed.

By Ainsley Harris

Qwatasia has a full-time job as a fraud analyst in Dallas, where she works the third shift—5 p.m. to 2 a.m.—Monday through Friday. But she finds it difficult to live on her salary. Sometimes, she’s short on rent as she waits for her next paycheck to hit.

Qwatasia got a flat tire a few months ago. In the past, she might have put the \$187 she needed to fix it on a credit card reserved for emergencies. But this time, she had another option: a cash advance from Dave, a banking app developed by a Silicon Valley startup that endears itself to users with help from its cartoon mascot, a bespectacled bear.

“Dave helped me out, because I could set a date when I would pay him back,” Qwatasia tells me—then corrects herself. “Pay the app back.” She adds, “I’m the type of person who doesn’t like to ask family. You’ve got to stand on your own two feet.”

Qwatasia is hardly alone. Millions of Americans have become regular users of products offering to help them bridge the gap between urgent expenses and biweekly paydays under the guise of encouraging financial independence. These so-called early wage access startups have collectively raised more than \$1 billion in venture backing in recent years, winning the support of elite VCs as well as celebrity investors such as Mark Cuban and Nas. By giving users advance access to their paychecks—in exchange for a tip or fee, or bundled into a subscription—they’re positioning themselves as an alternative to payday lenders (with their high APRs) and banks (with their onerous overdraft fees).

While a prior generation of fintech companies tended to focus on affluent consumers—people a lot like the VCs hearing those founders’ pitches—today’s entrants are more likely to target the types of consumers who would have delivered lunch to those pitch meetings. Dave, which has raised \$76 million in venture capital, helps users avoid overdraft fees with cash advances of up to \$75 per pay period. Earnin, which has raised \$190 million, gives users early access to as much as \$100 from their paychecks in a given day. Other companies, such as DailyPay and Even, partner with employers to provide payroll advance as an HR benefit. In a few cases, early wage access providers also aspire to offer checking and savings accounts.

These startups are responding to a genuine problem: In 2019, according to the Financial Health Network, interest and fees cost financially underserved U.S. consumers close to \$200 billion. But while these companies look friendlier than the incumbents they aim to disrupt, their incentive structure is the same: Most of these advance-pay startups make money when working people chronically struggle to make ends meet. Despite their talk of fairness and community, they show no signs of dismantling a system rigged against their customers.

Earnin is on a mission to restore worker rights that date to ancient times, at least according to founder and CEO Ram Palaniappan. “The Bible says that employees need to be paid before sunset,” he says. Indeed, early wage access startups were initially met with something akin to devotional praise. When Earnin, then called Activehours, first launched in 2014, one publication declared that it was disrupting the “very concept of payday.”

Earnin and its ilk landed in app stores around the same time that previously pioneering digital lenders were losing momentum. Startups like Lending Club, founded in 2006, had successfully introduced online personal loans to people with good credit scores, but struggled to expand into complementary products. At the top of the market, companies focused on student loan refinancing were duking it out to win over future millionaires.

Founders of advance-pay startups realized that the Great Recession's ripple effects had created an opportunity to serve the growing number of Americans living paycheck to paycheck. "Tens of millions of Americans who had access to credit in 2007 don't have it 10 years later," says David Scharf, a managing director at JMP Securities. "Prior to the recession, they may have had two credit cards. Now they have one with a lower line. This more restrained lending is one of the reasons this recovery is so prolonged, yet also so muted."

Early wage access startups appear to offer a mission-driven way to meet this consumer demand for credit, even as they deliver the kind of sticky business model that appeals to investors (users tend to open these apps regularly, presenting developers with opportunities to sell additional services). Companies in this category have commissioned research showing that their users are less stressed, less likely to quit their jobs, and more engaged and productive. The startups also wrap their services in consumer-friendly language, by using the term "advance" rather than "loan"; requesting "tips" instead of charging "interest"; and talking of advances being "restored," not "repaid."

Regulators in 11 states have taken a more skeptical view. They announced a joint investigation into the payroll-advance category last August, questioning whether these companies' tips—which users must opt out of—are usurious interest rates in disguise. If an Earnin user were to tip \$9 for a \$100 cash advance, as the app had been suggesting in some cases, the effective APR for the advance could be over 400%, depending on proximity to payday. Regulators also want Earnin to explain why it made larger loans available to more generous tippers—undermining the idea of a tip as voluntary. (Dave, which combines tips and subscription fees, also received a letter of inquiry from regulators, as did a handful of other apps.) Earnin users, meanwhile, have complained that the company sometimes triggers overdraft fees by automatically withdrawing repayment from users' accounts, restarting the very downward cycle they were trying to escape. Two class action lawsuits against Earnin are pending.

Palaniappan calls Earnin's tipping model a "pay it forward" innovation, rather than a legal loophole. "[Users] clearly understand how it works," he says. Nonetheless, he is taking a page from the Uber and Airbnb playbooks and recruiting "Earnin Advocates" willing to speak with elected officials about the benefits of the "community." The company also supports legislation in California that would ease restrictions on its business model.

As payroll-advance apps gain traction, employers are taking note. They're seeking out startups like Even, which works directly with companies to offer their workers access to its advance-pay and budgeting and saving features for a flat \$8-a-month subscription per employee. One of its largest partners is Walmart, which offers its 1.5 million U.S.-based workers subsidized access to Even. On the back end, another startup, PayActiv, helps process Even's transactions.

Even and PayActiv are part of a group of early wage access companies that integrate with employers' payroll systems. They've found traction in industries such as retail, hospitality, and telemarketing, where they're able to throw low-paid workers an emergency lifeline that's superior to payday lending. But they're nevertheless arming employers with a lever for increasing retention without increasing pay or benefits. Early access to your paycheck comes in handy, for example, when your employer downgrades its healthcare plan to a high-deductible one, as many have in recent years.

"If you're living paycheck to paycheck and all of a sudden your paycheck comes every day, that doesn't solve the problem," admits Jon Schlossberg, CEO of Even. "It just speeds up the cycle on which you get stressed about money." It's a situation that workers at Walmart, which currently pays a starting rate of \$11 an hour, may find familiar.

In the meantime, Dave and Earnin are also getting closer to employers, particularly those that fashion themselves as "platforms" and have suspect track records on matters of pay and worker protection. Earnin has a partnership with Uber that encourages drivers to link their Uber accounts to the service and get wages whenever they need them. Last year, Dave unveiled a feature called Side Hustle, which connects users with companies including Instacart, Lyft,

and Rover. The more Dave users turn to the app for gig work, the more the company earns in referral revenue. So far, 600,000 of Dave's 5.5 million users have completed Side Hustle applications.

Silicon Valley popularized the idea that we should “always be hustlin’ ” in pursuit of our dreams. American workers facing a less prosperous future than their parents’ generation have gotten the message—or at least a version of it. “If you really want the extra income, you’re going to take on any [job] suggestion. That’s the definition of being a hustler,” says Naiyasha, a Dave user who walks dogs and is a licensed massage therapist in addition to her full-time job as a personal assistant. “You can never have too many incomes.”

## **RULING CLASS**

How banks and regulators created an environment where startups thrive and people with limited funds struggle

### **1. Debit Cards**

Throughout the 1990s, banks push the use of debit cards for payments.

Consequence: Consumers start getting hit with more overdraft fees as they mix cash, check, and debit card payments and lose clarity around when transactions will clear.

Today: Startups including Chime and Dave have become unicorns by helping consumers monitor their overdraft risk and providing solutions.

### **2. Access to Credit**

Post-financial crisis, banks tighten lending standards in an effort to stanch the flow of mortgage losses.

Consequence: Millions of Americans see their credit limits lowered or their cards canceled.

Today: Americans are utilizing startups like Acorns for debit cards that offer credit-card-style rewards, companies like Upstart for online loans, and apps like Brigit for cash advances.

### **3. Deposit Advance**

In 2013, the Treasury sounds the alarm on deposit advances: short-term, high-cost loans in which banks automatically deduct repayment as soon as funds are available.

Consequence: Most banks drop deposit advances as a product, eliminating a popular form of short-term credit and a payday-lending alternative.

Today: Earnin and DailyPay offer deposit advances under the label of “early wage access.”

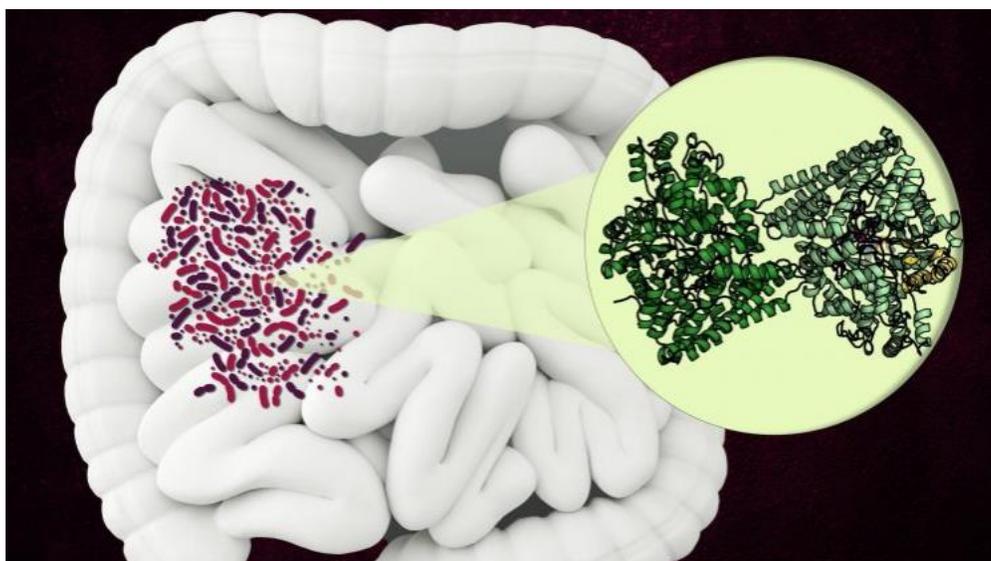
### **4. Payday Lending**

The Consumer Financial Protection Bureau plans to remove a rule that requires payday lenders to assess a person's ability to repay before issuing a loan.

Consequence: The CFPB's more lenient approach to payday lending suggests it will adopt a similar approach to early wage access.

Tomorrow: Payroll-advance regulation will likely play out at the state level, where regulators police financial services more aggressively.

By Anne Trafton, MIT



MIT researchers have discovered the structure of an unusual enzyme that some microbes use to break down a component of collagen in the human gut. Credit: Christine Daniloff, MIT

Scientists discover the structure of an enzyme, found in the human gut, that breaks down a component of collagen.

MIT and Harvard University chemists have discovered the structure of an unusual bacterial enzyme that can break down an amino acid found in collagen,

which is the most abundant protein in the human body.

The enzyme, known as hydroxy-L-proline dehydratase (HypD), has been found in a few hundred species of bacteria that live in the human gut, including *Clostridioides difficile*. The enzyme performs a novel chemical reaction that dismantles hydroxy-L-proline, the molecule that gives collagen its tough, triple-helix structure.

Now that researchers know the structure of the enzyme, they can try to develop drugs that inhibit it. Such a drug could be useful in treating *C. difficile* infections, which are resistant to many existing antibiotics.

“This is very exciting because this enzyme doesn’t exist in humans, so it could be a potential target,” says Catherine Drennan, an MIT professor of chemistry and biology and a Howard Hughes Medical Institute Investigator. “If you could potentially inhibit that enzyme, that could be a unique antibiotic.”

Drennan and Emily Balskus, a professor of chemistry and chemical biology at Harvard University, are the senior authors of the study, which appears today in the journal *eLife*. MIT graduate student Lindsey Backman and former Harvard graduate student Yolanda Huang are the lead authors of the study.

### **A difficult reaction**

The HypD enzyme is part of a large family of proteins called glycy radical enzymes. These enzymes work in an unusual way, by converting a molecule of glycine, the simplest amino acid, into a radical — a molecule that has one unpaired electron. Because radicals are very unstable and reactive, they can be used as cofactors, which are molecules that help drive a chemical reaction that would otherwise be difficult to perform.

These enzymes work best in environments that don’t have a lot of oxygen, such as the human gut. The Human Microbiome Project, which has sequenced thousands of bacterial genes from species found in the human gut, has yielded several different types of glycy radical enzymes, including HypD.

In a previous study, Balskus and researchers at the Broad Institute of MIT and Harvard discovered that HypD can break down hydroxy-L-proline into a precursor of proline, one of the essential amino acids, by removing the hydroxy modification as a molecule of water. These bacteria can ultimately use proline to generate ATP, a molecule that cells use to store energy, through a process called amino acid fermentation.

HypD has been found in about 360 species of bacteria that live in the human gut, and in this study, Drennan and her colleagues used X-ray crystallography to analyze the structure of the version of HypD found in *C. difficile*. In 2011, this species of bacteria was responsible for about half a million infections and 29,000 deaths in the United States.

The researchers were able to determine which region of the protein forms the enzyme's "active site," which is where the reaction occurs. Once hydroxy-L-proline binds to the active site, a nearby glycine molecule forms a glycy radical that can pass that radical onto the hydroxy-L-proline, leading to the elimination of the hydroxy group.

Removing a hydroxy group is usually a difficult reaction that requires a large input of energy.

"By transferring a radical to hydroxy-L-proline, it lowers the energetic barrier and allows for that reaction to occur pretty rapidly," Backman says. "There's no other known enzyme that can perform this kind of chemistry."

### **New drug target**

It appears that once bacteria perform this reaction, they divert proline into their own metabolic pathways to help them grow. Therefore, blocking this enzyme could slow down the bacteria's growth. This could be an advantage in controlling *C. difficile*, which often exists in small numbers in the human gut but can cause illness if the population becomes too large. This sometimes occurs after antibiotic treatment that wipes out other species and allows *C. difficile* to proliferate.

"*C. difficile* can be in your gut without causing problems — it's when you have too much of it compared to other bacteria that it becomes more problematic," Drennan says. "So, the idea is that by targeting this enzyme, you could limit the resources of *C. difficile*, without necessarily killing it."

The researchers now hope to begin designing drug candidates that could inhibit HypD, by targeting the elements of the protein structure that appear to be the most important in carrying out its function.

Reference: "Molecular basis for catabolism of the abundant metabolite trans-4-hydroxy-L-proline by a microbial glycy radical enzyme" by Lindsey RF Backman, Yolanda Y Huang, Mary C Andorfer, Brian Gold, Ronald T Raines, Emily P Balskus and Catherine L Drennan, 17 March 2020, eLife.

DOI: 10.7554/eLife.51420

The research was funded by the National Institutes of Health, a National Science Foundation Graduate Research Fellowship, Harvard University, a Packard Fellowship for Science and Engineering, the NSERC Postgraduate Scholarship-Doctoral Program, an Arnold O. Beckman Postdoctoral Fellowship, a Dow Fellowship, and a Gilliam Fellowship from the Howard Hughes Medical Institute.

***If we fail to help them immediately, their crisis will be the entire economy's crisis.***

By Derek Thompson

The spread of the coronavirus across the United States has caused a generalized shutdown of public life. Schools are closed, sports are canceled, and concerts are over. This is entirely appropriate. A pandemic is war, and public gatherings at the moment give aid and comfort to the biological enemy.

But this shutdown will crush the economy, starting with the restaurant industry. In the past 48 hours, several states, including Ohio and Illinois, and major cities, including New York City and Los Angeles, announced that restaurants will be closed or limited to takeout and delivery. Shelly Fireman, a New York restaurateur who runs several diners, called the fallout “worse than after 9/11.”

The consequences of these widespread closures may be hard to grasp. Americans now spend more at restaurants than at grocery stores—something they had never done before 2015. This modern dining revolution has made restaurants one of the country's most important sources of work. In 1990, manufacturing employment was almost three times larger than the food-service industry, but today there are about as many jobs in food service as in manufacturing. Restaurants are the new factories, and without them state and local economies across the country would fall to pieces. Food-preparation and food-service jobs now account for more than 10 percent of all employment in Nevada, Hawaii, and Florida. What's more, with the disappearance of brick-and-mortar retail stores from many cities, restaurants have become a rare bright spot. In 2019, restaurants and bars accounted for almost half of all new leases in Manhattan.

Social distancing has changed that landscape almost overnight. According to the booking website OpenTable, which publishes information for all 50 U.S. states and dozens of cities on a daily basis, online bookings held steady through February. But in the past week, reservations cratered by more than 40 percent in New York, Los Angeles, Boston, and Denver. In Seattle, where the outbreak is especially virulent, bookings last weekend were 60 percent lower than on the same day last year.

New executive orders ending dine-in service across the country could cut reservations to zero in most cities, threatening the employment of America's nearly 3 million waiters and waitresses.

“We are in uncharted waters,” said Steve Salis, a Washington, D.C.–based entrepreneur with several properties, including the BBQ restaurant Federalist Pig and Kramerbooks & Afterwords Cafe, a long-standing bookstore and restaurant. Same-store sales across his businesses had already declined up to 50 percent, he told me on Sunday, with the deepest pain at full-service restaurants.

Now that D.C. restaurants have officially shuttered for dine-in customers, Salis is looking to completely overhaul his business to keep workers paid and the community fed. “We have implemented more promotions around delivery,” he said. He also plans to expand catering-size orders available via “curbside pickups.” National chains are following the same script. On Monday, McDonald's, Starbucks, and other other fast-food franchises announced that their locations would be temporarily take-out only. This is the near future of American restaurants: Dine-ins are transforming into drive-throughs, and their chefs now operate de facto neighborhood groceries for prepared food.

How long this transformation lasts is unclear. Arguably, however, these measures are an acceleration toward the future rather than a break from the past. Last year, analysts predicted that in 2020 Americans would for the first

time spend more money “off-premise”—on takeaway and delivery—than on dining in restaurants. The coronavirus outbreak all but guarantees that this prediction will come true.

Restaurants in a pandemic are like beachfront properties in a hurricane. Their devastation is both a tragedy and an omen of greater havoc to come. Already operating at paper-thin margins, restaurants face the loss of their entire dine-in business, but they will still have to make rent. In the same way, hotels, airlines, and the entire face-to-face services sector are looking ahead at several months without customers, yet they will still have to make regular payments on corporate loans.

This is our great economic crisis in a nutshell: Consumers are vanishing, but financial obligations are not. Without a major intervention, the entire global leisure and retail economy—and soon, perhaps, the entire economy, period—is facing mass layoffs, mass bankruptcy, or both.

There is only one solution to this problem: The public sector must step in and play consumer for several months, until the virus passes. Salis calls for a comprehensive financial-aid package that can help companies “[subsidize] labor, vendors, loans, rent or mortgage, and other payments through these significant disruptions so businesses can come out on the other side empowered to move forward and not shut down operations indefinitely.” Perhaps this will require a one-time \$1 trillion infusion of cash to U.S. households to protect people from the inevitable downturn. Perhaps it will require hundreds of billions of dollars in grants or cheap loans to affected businesses. Very likely, it will require a bit of both. As with social distancing, economic solutions that sound rash and extreme today may sound conservative and inevitable in 48 hours.

A global pandemic is a planet-size pause button for public life. The right stimulus ought to press a similarly large pause button to freeze in place the financial well-being of U.S. families and businesses. “Restaurants are the lifeblood of many communities throughout the country,” Salis told me. “When this pandemic is under control—and it will be—we look forward to seeing people reconnect in profound ways over meals. It’s one of life’s greatest pleasures.”

By Erik Von Weber

AWS CEO Andy Jassy showed signs of frustration at his AWS re:Invent keynote address in December.

Customers weren't moving to the cloud nearly fast enough for his taste, and he prodded them to move along. Some of their hesitation, as Jassy pointed out, was due to institutional inertia, but some of it also was due to a technology problem related to getting entrenched, on-prem workloads to the cloud.

When a challenge of this magnitude presents itself and you have the head of the world's largest cloud infrastructure vendor imploring customers to move faster, you can be sure any number of players will start paying attention.

Sure enough, cloud infrastructure vendors (ISVs) have developed new migration solutions to help break that big data logjam. Large ISVs like Accenture and Deloitte are also happy to help your company deal with migration issues, but this opportunity also offers a big opening for startups aiming to solve the hard problems associated with moving certain workloads to the cloud.

Think about problems like getting data off of a mainframe and into the cloud or moving an on-prem data warehouse. We spoke to a number of experts to figure out where this migration market is going and if the future looks bright for cloud-migration startups.

### **Cloud-migration blues**

It's hard to nail down exactly the percentage of workloads that have been moved to the cloud at this point, but most experts agree there's still a great deal of growth ahead. Some of the more optimistic projections have pegged it at around 20%, with the U.S. far ahead of the rest of the world.

David Linthicum, chief cloud strategy officer at Deloitte, has been working with cloud technologies for nearly two decades, and says the 20% figure is probably a pretty good estimate for infrastructure. It could be double that, perhaps, if you include SaaS and infrastructure together, but he says it's probably not that much.

Linthicum says that to this point, companies have mostly moved the easy stuff, but now comes the more challenging workloads. It won't be that easy to move these, especially if you want to take advantage of the fact you're in the cloud.

"You don't want to take crappy systems from on-prem and move them to the cloud," he says. "Rank-and-file IT folks moving to the cloud are trying to improve their systems as they relocate, taking advantage of the relocating." That means if a startup can come up with a clever solution for moving deep-rooted on-prem data to the cloud, they could be setting themselves up for a big market for some time to come.

### **Getting a move-on**

Joshua Bergin, director and tech advisor at Amazon, says before you start moving to the cloud, you need to figure out what you have, which can be challenging inside larger organizations: "What we found a lot, and this is where we've been investing significantly, is that a lot of people don't even know what they're running. So they have these collection facilities that might be just closets to professional data centers that they've built or co-location facilities."

Simply getting an inventory of data and applications is a good first step, he advised. To help in this regard, the company made two key acquisitions last year when it nabbed CloudEndure and TSO Logic in quick succession. "In

CloudEndure’s case, it actually simplifies migrating your applications, and TSO Logic helps give you recommendations to understand what applications you’re running,” he says.

“Then it helps you discover the [operating] environments and gives you the ability as part of the migration to right size and improve your costs as you do the migration.”

Debanjan Saha, vice president of data analytics at Google, says that beyond that, there is a complex series of steps involved in moving data from on-prem to the cloud.

“You are not only moving your data and your schema, which is essentially the data model, but you also need to move your application stack with that, which is, for example, ETL tools that you have built, ETL scripts that you have built, which is what feeds data into the data warehouse.” He says part of it is automated, but part of it requires partners like Accenture or WiPro to help. Smaller partners like startups can also help.

### **Making investments**

Creighton Hicks, a partner at Dell Technologies Capital, agrees that moving those next workloads won’t be easy, and as an investor he sees an opportunity in that space. In fact, he has invested in Datometry, a company that is helping move Teradata data warehouses to the cloud along with the proprietary extensions and custom applications built on top of that data.

They achieve this through virtualization, allowing customers to move the legacy workloads much faster without having to rewrite these applications from scratch for the cloud, precisely the kind of difficult workload Linthicum alluded to.

“The question is, how do you move the workloads that are not moving quickly or at all. What’s keeping them on-prem? So that’s an area where the investment thesis definitely was in line with that with respect to Datometry,” he says.

Another example of venture investment in a cloud migration tool is Model9, an Israeli early-stage startup that recently got a \$9 million Series A investment led by Intel Capital. The company helps move data between mainframes and the cloud, a difficult problem to solve. As CEO Gil Peleg told TechCrunch at the time of his funding:

Mainframe data is locked behind proprietary storage that is inaccessible to anything that’s happening in the evolving, fast-moving technology world in the cloud. And this is where we come in with patented technology that enables mainframes to read and write data directly to the cloud or any non-mainframe distributed storage system.

It’s also worth noting that Google Cloud acquired Cornerstone last month, another company that helps move legacy mainframe workloads to the cloud.

These are just some of the examples of the companies being created to solve the tough cloud migration problems that exist out there. One thing is clear — there is going to be a big demand for these kinds of solutions as companies look to shift more of their workloads, especially the entrenched ones.

Companies that think creatively will be poised to capture this market in the coming years. It’s a huge opportunity. Just ask Andy Jassy.

By Ingrid Fadelli

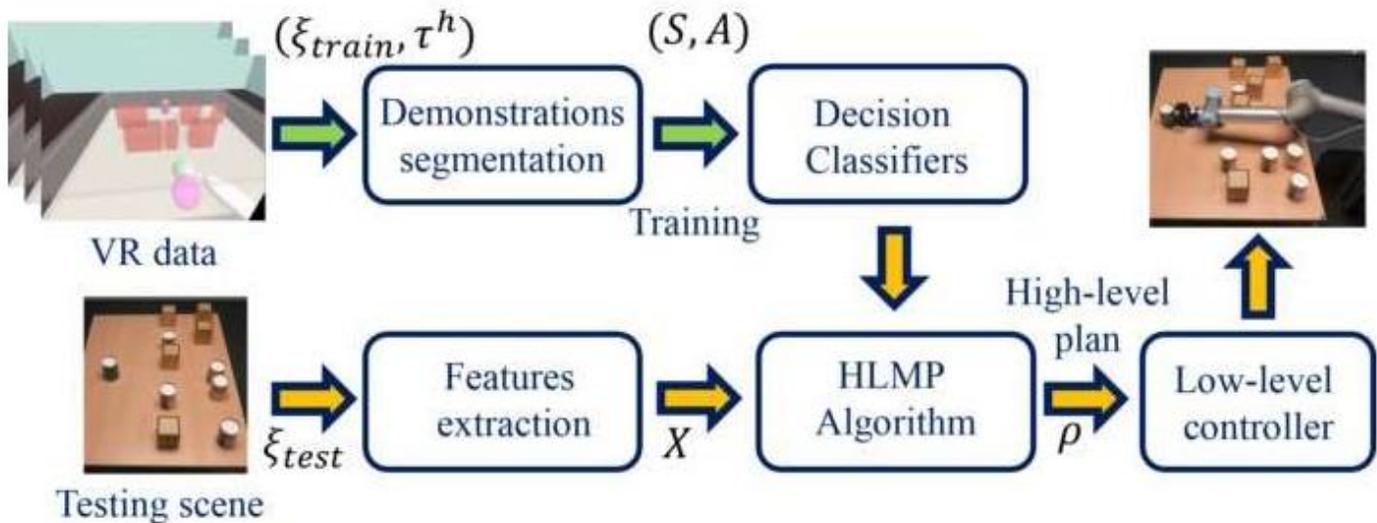


Figure outlining how the human-like planner works. Credit: Hasan et al

While research in the field of robotics has led to significant advances over the past few years, there are still substantial differences in how humans and robots handle objects. In fact, even the most sophisticated robots developed so far struggle to match the object manipulation skills of the average toddler. One particular aspect of object manipulation that most robots have not yet mastered is reaching and grasping for specific objects in a cluttered environment.

To overcome this limitation, as part of an EPSRC-funded project, researchers at the University of Leeds have recently developed a human-like robotic planner that combines virtual reality (VR) and machine learning (ML) techniques. This new planner, introduced in a paper pre-published on arXiv and set to be presented at the International Conference on Robotics and Automation (ICRA), could enhance the performance of a variety of robots in object manipulation tasks.

"Our research goal is to develop better robotic systems; systems that can help humans in a range of tasks, ranging from exploring hazardous environments to helping a child learn to write," Prof. Anthony G. Cohn, principal investigator for the study, told TechXplore. "So we formed a multidisciplinary group of psychologists and computer scientists to explore whether we could capture the behavior of humans and reverse-engineer the rules that humans use when reaching for objects."

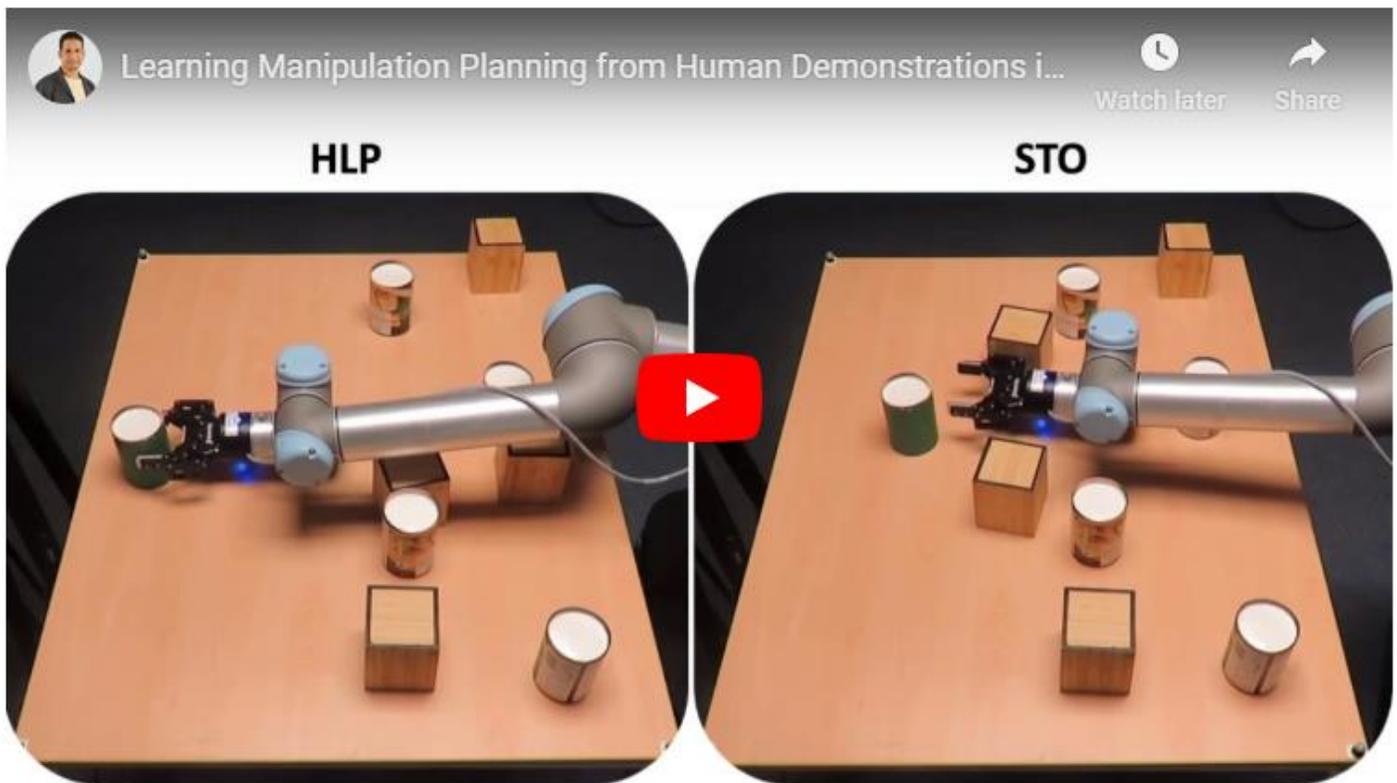
In contrast with other researchers who trained machine learning classifiers on images of cluttered environments, Cohn and his colleagues wanted to generate training data using new immersive technologies. In their study, they thus used VR equipment to collect data on humans completing manipulation tasks.

Subsequently, they used ML classifiers to analyze the VR data they collected and extract general rules that may be underlying human decision-making. The planner uses these rules to plan efficient strategies for robots completing object manipulation tasks.

"We wanted the resulting plans executed by the robot to also be 'human legible,' in the sense that they would be the ones that a human would expect another human to execute, which is not the case for many current robot plans," Cohn explained.

The decisions of humans who are completing manipulation tasks appear to be mostly guided by qualitative representations (i.e., not the exact distance and direction of all objects in their surrounding environment, but rather relative distances and directions). In their study, the researchers tried to better understand these decision-making processes in order to partly reproduce them in ML classifiers.

"We explored how humans reach in scenarios where the objects they grasp have particular spatial relationships and used methods developed by AI researchers at the University of Leeds to describe qualitatively where the objects were located," Dr. Mohamed Hasan, a research fellow working on the project, explained. "This meant that the planner could classify the qualitative spatial relationships between objects and then select the actions that humans would use in that scenario."



The approach proposed by Cohn and his colleagues allows robots to identify effective actions to reach for an object in a cluttered space much faster than they would if they had to consider all possible actions. It does this by producing a high-level plan, which is represented as a sequence of key waypoints and moves. This plan is transmitted to a standard low-level planner, which uses it to plan detailed trajectories for the robot's arm.

"Our planner works in a way that resembles the process of planning a journey by choosing which towns to go through and only later deciding exactly which roads and lanes to take," Cohn said. "We found that this approach makes our human-like planner much more efficient than existing planners."

The researchers evaluated their planner in a series of experiments, testing it in VR scenarios where humans completed manipulation tasks in physics-based robot simulations and using a real robotic gripper. All three evaluations yielded very promising results, with the human-like planner outperforming a state-of-the-art, standard trajectory optimization algorithm.

The planner devised by Cohn and his colleagues was able to generate effective strategies that allowed robots to reach for objects in cluttered environments faster and more efficiently than they would when using the standard trajectory optimization techniques. In addition to introducing a promising human-like planner for robot manipulation tasks, the study shows that VR technology can be used to study human behavior and gain a better understanding of decision-making processes.

"Our VR platform, which was developed in-house at the University of Leeds, enabled us to record hundreds of reaches in a short period of time, but we could also change the layout of the environment between each trial and easily present exactly the same environment to different human participants," said Prof. Mark Mon-Williams, co-investigator and a cognitive psychologist, explained. "Our findings support our recent suggestions that VR will become one of the most ubiquitous tools in psychological research. Yet we also found that rules underpinning human action selection can be captured by ML methods."

In the future, the planner developed by Cohn and his colleagues could help to enhance the manipulation skills of both existing and new robots, allowing machines to select actions more efficiently and potentially even explain the "reasoning" behind their decisions. This recent study could also encourage other researchers to use VR data when investigating human decision-making processes, which could then be better reproduced in machines.

The ultimate goal of the research is to build intelligent robots that will understand and anticipate human intentions in human-robot collaboration scenarios. Ideally, such robots would also be able to respond in human-like ways, communicating with human users similarly to how another human would.

"The current work is a proof of concept, so we now plan to take the method we developed and exploit its immense potential," Mon-Williams said. "It has become clear that this combination of computer science and psychology is a very useful approach that has the potential to shed light on human action selection, which is important for a number of reasons, including understanding how to treat medical conditions such as strokes, as well as help us design more efficient robots. We are currently working on our next series of experiments and projects."

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**More information:** Human-like planning for reaching in cluttered environments, Mohamed Hasan, Matthew Warburton, Wisdom C. Agboh, Mehmet R. Dogar, Matteo Leonetti, He Wang, Faisal Mushtaq, Mark Mon-Williams, Anthony G. Cohn, arXiv: 2002.12738 [cs.RO]. [arxiv.org/abs/2002.12738](https://arxiv.org/abs/2002.12738), set to appear ICRA-20 (the International Conference on Robotics and Automation).

[artificial-intelligence.leeds. ... uman-like-computing/](#)

Studying human behaviour with virtual reality: The Unity Experiment framework. Jack Brookes, Matthew Warburton, Mshari Alghadier, Mark Mon-Williams, Faisal Mushtaq, DOI: [10.3758/s13428-019-01242-0](https://doi.org/10.3758/s13428-019-01242-0). <https://link.springer.com/article/10.3758/s13428-019-01242-0>

**Neolix, of Beijing, claims the epidemic has boosted sales of its deliverybots**

Neolix, a maker of urban robo-delivery trucks, made an interesting claim recently. The Beijing-based company said orders for its self-driving delivery vehicles were soaring because the coronavirus epidemic had both cleared the roads of cars and opened the eyes of customers to the advantages of driverlessness. The idea is that when the epidemic is over, the new habits may well persist.

Neolix last week told Automotive News it had booked 200 orders in the past two months after having sold just 159 in the eight months before. And on 11 March, the company confirmed that it had raised US \$29 million in February to fund mass production. Of course, this flurry of activity could merely be coincidental to the epidemic, but Tallis Liu, the company's manager of business development, maintains that it reflects changing attitudes in a time of plague.

"We've seen a rise in both acceptance and demand both from the general public and from the governmental institutions," he tells IEEE Spectrum. The sight of delivery bots on the streets of Beijing is "educating the market" about "mobility as a service" and on "how it will impact people's day-to-day lives during and after the outbreak."

During the epidemic, Neolix has deployed 50 vehicles in 10 major cities in China to do mobile delivery and also disinfection service. Liu says that many of the routes were chosen because they include public roads that the lockdown on movement has left relatively empty. The company's factory has a production capacity of 10,000 units a year, and most of the factory staff has returned to their positions, Liu adds. "Having said that, we are indeed facing some delays from our suppliers given the ongoing situation."

Neolix's deliverybots are adorable—a term this site once used to describe a strangely similar-looking rival bot from the U.S. firm Nuro. The bots are the size of a small car, and they're each equipped with cameras, three 16-channel lidar laser sensors, and one single-channel lidar. The low-speed version also has 14 ultrasonic short-range sensors; on the high-speed version, the ultrasonic sensors are supplanted by radars.

If self-driving technology benefits from the continued restrictions on movement in China and around the world, it wouldn't be the first time that necessity had been the mother of invention. An intriguing example is furnished by a mere two-day worker's strike on the London Underground in 2014. Many commuters, forced to find alternatives, ended up sticking with those workarounds even after Underground service resumed, according to a 2015 analysis by three British economists.

One of the researchers, Tim Willems of Oxford University, tells Spectrum that disruptions can induce permanent changes when three conditions are met. First, "decision makers are lulled into habits and have not been able to achieve their optimum (close to our Tube strike example)." Second, "there are coordination failures that make it irrational for any one decision maker to deviate from the status quo individually" and a disruption "forces everybody away from the status quo at the same time." And third, the reluctance to pay the fixed costs required to set up a new way of doing things can be overcome under crisis conditions.

By that logic, many workers sent home for months on end to telecommute will stay on their porches or in their pajamas long after the all-clear signal has sounded. And they will vastly accelerate the move to online shopping, with package delivery of both the human and the nonhuman kind.

On Monday, New York City's mayor, Bill de Blasio, said he was suspending his long-running campaign against e-bikes. "We are suspending that enforcement for the duration of this crisis," he said. And perhaps forever.

**Drones offer some promising solutions to some of our perennial public challenges. We'll take a look at a few key areas in which they're already starting to make a difference across various community issues.**

By Jori Hamilton

Drones have become a familiar aspect of our contemporary world. Over the past decade, they've graduated from expensive toys of the rich to affordable items that many of us have the opportunity to experience. They are used in photography and deliveries, and have even become the subject of their own racing events. But drones also have a vital part to play in the public sector.

This isn't necessarily limited to their military applications, either. Governments and public services — local and national — have begun to explore ways in which drone tech can make a real difference in our lives. Public leaders are embracing the benefits of these small aerial devices beyond the limited applications most of us are familiar with.

Drones offer some promising solutions to some of our perennial public challenges. We'll take a look at a few key areas in which they're already starting to make a difference across various community issues. How are they being used, and what innovations do they offer?

### **Safer Roads**

Without efficient and safe roadways, many of our industries, and indeed our lives, would suffer. If the trucking industry is believed to reflect the health of our economy, this means our roads become the arteries maintaining its nourishment. Public sector fleets have begun to find ways to use technology in vehicles in order to improve safety. This includes the use of telematics in school buses, using data analytics for accident prevention and to monitor driver behavior. But governments are also looking above and beyond the vehicle itself to improve roads.

As most accidents are due to human error and driver activities, more government agencies are utilizing drones to monitor drivers in real-time. Last year, during its Vision Zero week that was intended to bring awareness to traffic safety, the UK's Metropolitan Police Service used an unmanned aerial vehicle (UAV) to identify drivers engaging in unsafe behaviors and relay this information to roadside officers to respond quickly and effectively. But drone use for road safety goes further than simple surveillance; they are making the driving surface itself safer.

In previous years, getting an accurate assessment of the condition of roads, and the dangers any faults could present, required costly, time-consuming manual surveyance. Recently, Microsoft teamed up with holding company Sund & Bælt to produce a solution that used drones to quickly and thoroughly map the condition of the Belt bridge in Denmark. The drone flew around the structure, capturing road surface and structural images, which were then uploaded to the cloud. The data was then analyzed by bespoke artificial intelligence (AI) software to identify cracks and potential problem areas, with repair priorities then provided to teams of engineers. As drone and AI technology continue development, road surveys by UAVs could become a familiar feature.

### **Emergency Preparedness and Response**

As we continue to face the potential dangers associated with the irreversible effects of climate change, we can also expect more natural disasters. Recovery from disaster is often dependent upon emergency services' ability to respond quickly and effectively. This means that there is a constant need to develop new tools that can be used to assist efforts — drones have emerged as one of these tools.

In the aftermath of a disaster, there is still a significant level of danger presented by unstable structures and damaged utilities; this means that maintaining the safety of rescue workers is often difficult. The size and

maneuverability of UAVs, coupled with high definition cameras, means drones are now being used on the front line of disasters. Drones are capturing images for damage assessment, which can then be used to make 3D maps that allow responders to make safe, effective decisions. They're even being used to deliver blood, vaccines, and other emergency health supplies to medical personnel in hard to reach places.

Public safety officials have also begun to utilize drones in various ways to prevent wildfires or minimize their spread. UAVs have already gathered data at times in which conditions have been too smokey for helicopter pilots, allowing emergency services to develop fast, smart responses. They have also been deployed to survey land in California and Oregon, spotting the start of potential wildfires so that they can be addressed early. Sometimes their use is creative and unexpected. In 2019, drones delivered "dragon eggs" in California; these self-igniting devices initiated controlled burns of overgrown areas in order to prevent the potential for larger, more destructive blazes.

## **Agriculture**

In order for any population to thrive, there needs to be a robust agricultural industry. While many public officials are actively engaged in developing smart cities, there are those who have been tasked with making certain our landscapes will be feeding us well into the future. Drones have found a place in helping with this.

The Department of Agriculture in the U.S., in association with teams of farmers, has been experimenting with using drones in the surveying of crops in Colorado. The UAVs have been mounted with infrared cameras, which are able to provide data on soil moisture. This information is then used to calculate how much water crops are consuming, and farmers are provided guidance on strategic irrigation. This is intended not just to provide information to farmers but to also maintain a balance that ensures the Colorado river — which serves an estimated 40 million people — isn't overused to the point of drought.

Around the world, public agricultural agencies are encouraging farmers to make use of UAVs and the data they can provide. The European Commission's 2018 Drones in Agriculture report asserted that one of the keys to meeting growing food demand is incorporating Big Data and the IoT in farming. The same resource reported that drones can be used to quickly produce 3D mapping of fields, in order to design more efficient seed-planting patterns. Drones can also use multispectral cameras to produce orthomosaic maps that help farmers monitor the health of their crops on a more frequent basis and level of detail than was previously practical.

## **Conclusion**

Drones are much more than recreational and photographic flying machines. Their ability to maneuver into difficult positions, deliver supplies into remote areas, and gather huge amounts of data is making an impact on how the public sector operates. Between assisting rescue efforts, and supporting agriculture, they have the ability to impact our lives in meaningful ways.

By Maurizio Di Paolo Emilio

Microchip Technology Inc. has launched a range of IoT solutions for rapid prototyping by using cloud connectivity for all integrated microcontroller solutions.

IoT design is characterized by pairing the appropriate microcontroller solutions with the ideal connection protocol for your application. Microchip Technology Inc. announced a line-up of full-stack, embedded development solutions that provide any number of such combinations. The line ranges from the smallest PIC and AVR microcontrollers (MCUs) for sensors and actuators, to 32-bit MCU gateway and microprocessor (MPU) solutions for edge computing. Connectivity options include Wi-Fi, Bluetooth or 5G narrowband technologies, all while maintaining a security foundation with support from its Trust Platform for the CryptoAuthentication family.

### IoT design

Usually, the first step is to choose the ideal development kit for your prototype. Trying to build a cloud-connected IoT system from scratch can be a daunting task. It can be costly and time-consuming and requires expertise in many different engineering disciplines. Today's developers face more challenges than ever in design decisions: longer development time, higher security threats.

IoT sensor networks and intelligent devices will be woven into virtually every aspect of our environment: our homes, physical objects, transportation and communication systems, clothing and the human body, enabling us to connect and exchange data. There are potential opportunities in the IoT, but it's going to be hard to take advantage of them all unless workflows are simplified, and components are more modular.

For IoT applications, there could be three different types of projects:

1. Cloud-connected projects: the cloud is built with servers that use dedicated software to analyze and process data collected by systems.
2. Projects connected to a local network: they use an intranet network to communicate.
3. Gateway projects: gateway systems are often used to adapt existing systems to the Internet.

Development kits and other prototyping platforms are proving vital to level the IoT supply chain, accelerate innovation, and stimulate anyone with the ideas and ambitions to design and create successful IoT solutions.

### Microchip solutions

“We still see that the adoption rate of IoT is fairly slow,” said Oyvind Strom, marketing director at Microchip Technology. “There are many solutions out there, but we see a large customer base where not necessarily all of them are comfortable with IoT. What we have been doing is launching edge nodes and gateways where ease-of-use is in focus. “

The security hardware solutions help protect against security threats, ranging from remote cyber-attacks to the creation of counterfeit products.

Microchip offers a range of new, intelligent, connected, and secure rapid prototyping solutions. There are four new Wi-Fi development platforms for the Internet of things through the PIC platform and the AVR platform. And two new Bluetooth prototyping boards for the PIC and AVR product lines will expand the choice of IoT prototyping. In addition, a new IoT gateway solution with Amazon GreenGrass and Azure will complete the portfolio. The

partnership with Sequans will also allow implementing new kit solutions for LTE-M and M/NB-IoT infrastructure connections.

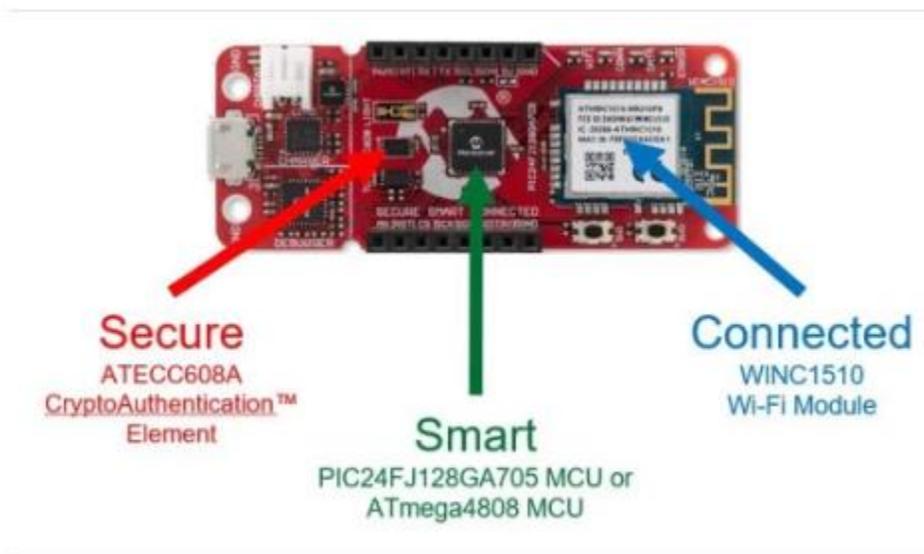
Each solution is designed to focus on ease of use and rapid development for intelligent industrial, medical, consumer, agricultural, and retail applications with security in mind. The wide choice of connectivity technologies, combined with the full range of microcontroller and microprocessor performance and peripheral features, makes these solutions scalable in a wide range of markets.

“When the customer wants to develop an IoT solution, you can either do IoT without the cloud or you can do IoT with the cloud. And cloud computing is definitely one of the fastest-growing areas in the world. There are three major cloud companies. It’s Google, Amazon and Microsoft. We are partnered with all of them,” said Strom.

Microchip’s broad portfolio includes the following solutions designed to reduce project costs and development complexity. The PIC-IoT WA and AVR-IoT WA boards are two new PIC and AVR MCU development boards. They developed in collaboration with Amazon Web Services (AWS), which helps designers natively connect IoT sensor nodes to the AWS IoT Core service via Wi-Fi.

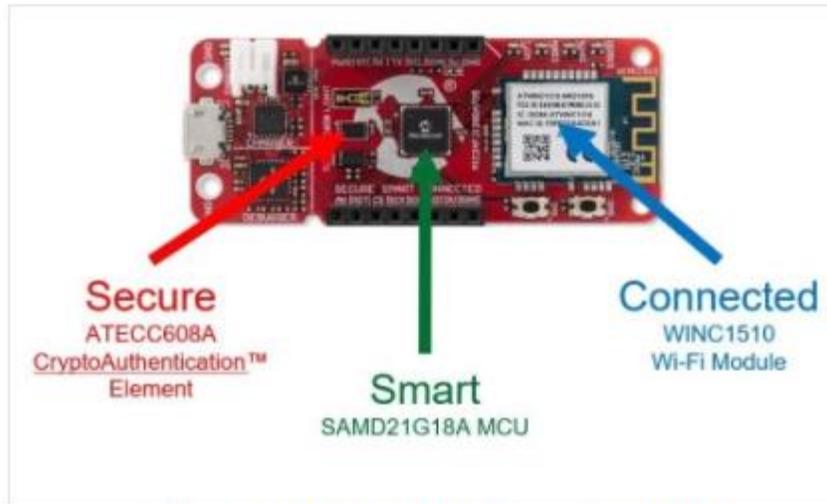
“When you buy this board, you basically plug it with the USB plug to your PC, and it will bring you to a dedicated web-page where you enter your Wi-Fi credentials, and you will literally stream data to the Amazon cloud within 30 seconds from plugging that board into your computer for the first time. And from that you can continue to develop your application with our comprehensive ecosystem around this board. It’s a very powerful board done with the most cost-efficient microcontrollers that you find in the industry, and it shows that you don’t need to go to 32-bit platforms to do edge node IoT.” Said Strom.

The two boards are supplied with a temperature sensor and a light sensor for demonstration purposes only. A microbus expansion socket allows adding more than 300 different sensors from click boards that we also support in our ecosystem (figure 1).



*Figure 1: PIC/AVR-IoT WA board [Source: Microchip]*

The SAM-IoT WG board connects the Google Cloud IoT Core with the popular SAM-D21 Arm Cortex® Mo+ 32-bit Microchip range of microcontrollers (Figure 2).



**Figure 2: SAM-IoT WG [Source: Microchip].**

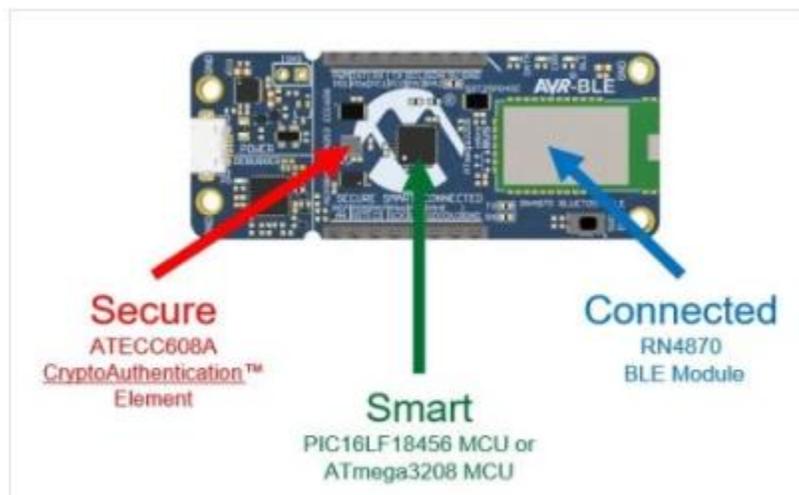
The Azure IoT SAM MCU-based Internet of Things development platform integrates the Azure IoT SDK and Azure IoT services with Microchip’s MPLAB X ecosystem of development tools. The card offers much more computing performance. In addition to transmitting your data, you can perform analysis by using artificial intelligence on the board.

“Predictive-maintenance type of applications, for instance, could be one. The board can also be used for vision. These kinds of high-end applications for the IoT nodes would be a suitable target for this platform,” said Strom.

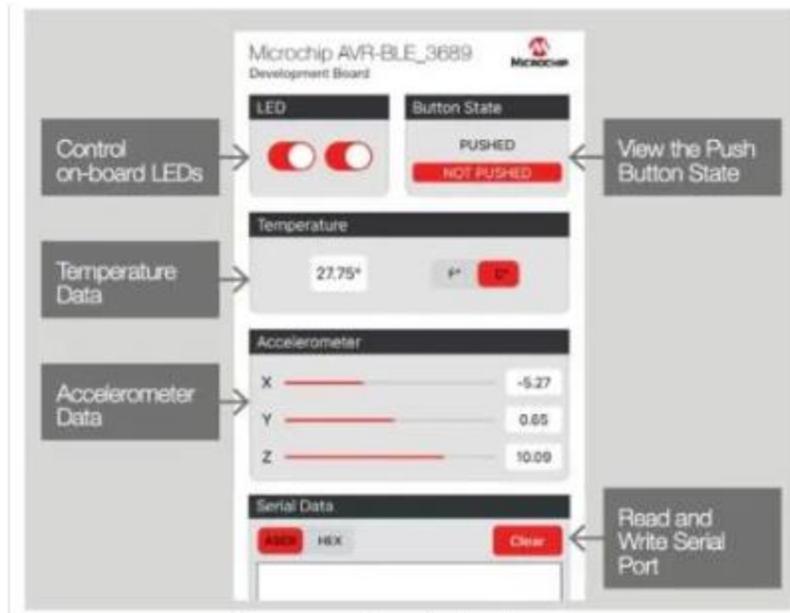
In addition to Wi-Fi boards, there are many requests for the implementation of Bluetooth in the industrial sector. All types of maintenance and repair of industrial equipment today are performed with integrated Bluetooth. The service technician can read an error code and things like that from his tablet or phone to avoid having to act mechanically inside the machine.

The PIC-BLE and AVR-BLE boards are based on PIC and AVR microcontrollers for sensor node devices that connect to mobile devices for industrial, consumer, and security applications and the cloud via Bluetooth Low Energy (BLE) gateways.

To ensure that only authorized devices can connect to the embedded device, an on-boarded secure element IC complete the Root of Trust from the embedded device up to the Cloud.



**Figure 3: PIC/AVR-BLE board [Source: Microchip]**



**Figure 4: The LightBlue app**

The main onboard sensors are temperature, light, and a three-axis accelerometer. It is possible to implement other external click board sensors and develop your custom application starting from LightBlue.

As long as you can take advantage of Wi-Fi and BLE, it would help if you always had a gateway solution. Wi-Fi could be the router you have at home, but if you want a closed network, you will also need to provide a gateway in your application.

The gateway solution with AWS IoT Greengrass is based on the latest Wireless System On Module (SOM), the ATSAMA5D27-WLSOM1, which integrates the SAMA5D2 MPU, the WILC3000 Wi-Fi combo module and Bluetooth fully powered by the high-performance MCP16502 power management integrated circuit (PMIC).

“These solutions are fully certified with the AWS Greengrass solution. Greengrass is Amazon’s solution where you have cloud computing locally on your node. This can have many advantages, including near real-time responses and the ability to operate even if your internet connection is down” said Strom

Another solution announced by Microchip in collaboration with Sequans is the LTE-M/NB-IoT Development Kit. It includes modules based on Sequans’ Monarch chips that enable coverage of IoT nodes and take advantage of the latest low-power 5G cellular technology.

The idea is that a gateway is again an obstacle for the customer. If you want to transmit data directly to the cloud, an LTE- M/NB-IoT solution is the way to go. Right now, large networks are starting to roll out their 5G networks, and with 5G, they will enable a huge amount of IoT nodes directly to mobile networks.

There are two standards in the world. There is one called LTE-M and another called NB-IoT. They are close but the different regions have different standards (Figure 5).

Sequans has 5G technology that can be used in the Americas, all European countries, and also Japan and China. With this solution, Microchip can serve customers around the world with LTE-M /NB-IoT technology and IoT technology, with all major networks around the globe.



*Figure 5: LTE or M/NB-IoT development kit [Source: Microchip].*

Microchip's new IoT solutions are based on the company's extensive ecosystem of development tools, focused on the MPLAB X Integrated Development Environment (IDE). Code generators such as the MPLAB X Code Configurator (MCC) automate and speed application code creation and customization for smaller PIC and AVR microcontrollers. At the same time, Harmony's software libraries support all 32-bit solutions for microcontrollers and microprocessors.

**Soldering can make or break a PCB, both figuratively and literally. This article offers basic tips and nine specific problems/mistakes to look out for when doing a soldering job.**

By Jonathan Bara

The quality of the soldering has a tremendous impact on the overall quality of the PCB. Through soldering, different parts of the PCB are connected to other electrical components to make a PCB function properly and serve its purpose. When industry professionals are evaluating the quality of electronic components and devices, one of the most prominent factors in their assessment is the caliber of the soldering work.

To be sure, soldering is quite straightforward. But it does take practice to master. As the saying goes, “practice makes perfect.” Even a complete novice can make functional solders. But for the overall longevity and functionality of the device, a clean and professional soldering job is the way to go.

In this guide, we’ve highlighted some of the most common problems that can happen during soldering. If you would like to know more about what it takes to make perfect solders that last, this is the guide for you.

### **What is the Perfect Solder Joint?**

It’s difficult to encompass all types of solder joints into one comprehensive definition. Depending on the type of solder, PCB used, or component connected to the PCB, the ideal solder joints might vary drastically. Still, most of the perfect solder joints have:

- Complete, solid wetting
- A smooth and shiny surface
- A neat concave fillet

To achieve an ideal solder joint, regardless of whether it’s an SMD solder joint or a through-hole solder joint, it’s necessary to use the right amount of solder, an appropriate solder iron tip heated to an accurate temperature, and a prepped PCB contact with a removed oxide layer.

Here are nine of the most common problems and mistakes that can happen on solders, usually when soldered by an inexperienced worker:

#### **1. Solder Bridges**

PCBs and electronic components are becoming smaller and smaller, making it difficult to maneuver around the PCB, especially when trying to solder. If you’re using a solder iron tip that’s too large for the PCB, you might create unwanted solder bridges.

A solder bridge is when soldering material connects two or more PCB connectors. This is quite dangerous and, if undetected, can cause the board to short circuit and burn out. Make sure to always use the right size of soldering iron tip to prevent solder bridges.

#### **2. Too Much Solder**

Novices and beginners tend to use too much solder [when soldering](#), and a large bubble-like solder ball forms at the solder joint. Besides looking like a weird growth on the PCB, it can also be difficult to spot if the solder joint is functional. There’s plenty of room for mistakes under that ball of solder.

The best practice is to use solder conservatively and, if necessary, add more if the joint needs it. Strive for a clean solder with a nice concave fillet.

### 3. Cold Joints

Cold joints occur when the soldering iron is at a lower-than-optimal temperature, or the duration of the heating of the joint was too short. Cold joints have a dull, messy, pock-marked appearance. In addition, they have a shorter lifespan and are less reliable. It's also difficult to assess whether a cold joint will perform well under current or limit the functionality of the PCB.

### 4. Burnt Joints

Burnt joints are the complete opposite of cold joints. It's obvious that the soldering iron operated at a higher-than-optimal temperature, the solder joint exposed the PCB to heat way too long, or a layer of oxide was still present on the PCB, preventing optimal heat transfer. The joint has a burnt appearance, and if the pads have lifted at the joints, the PCB might be damaged beyond repair.

### 5. Tombstones

Tombstones often occur when trying to connect electronic components such as transistors and capacitors to the PCB. If all sides of the component are properly connected to the pads and soldered, the component will be straight. Failing to achieve the necessary temperature for the soldering process might cause one or more sides to lift, making a tombstone-like appearance. Tombstoning affects the longevity of the solder joint and might negatively affect the thermal performance of the PCB.

One of the most frequent problems that's causing tombstoning during the reflow soldering process is the uneven heating in the reflow oven, which can cause premature wetting of the solder in some areas of the PCB versus other areas. The uneven heating issue usually occurs for home-made reflow ovens. That's why we recommend [acquiring professional equipment](#).

### 6. Insufficient Wetting

One of the most common mistakes by beginners and novices is the lack of wetting of the solder joints. A badly wetted joint has less solder than necessary to make a proper connection between the PCB soldering pads and the electronic components attached to the PCB by solder.

Poorly wetted joints will almost certainly limit or impair the performance of the electrical device, suffer from poor reliability and longevity, and might even cause a short that could fatally damage the PCB. They also often occur when solder used in the process is insufficient.

### 7. Skips

[Solder skips can occur](#) in the factory where the robots solder components to PCBs or at the hands of an inexperienced solderer. It might occur due to a lack of concentration on the part of a human operator. Likewise, poorly configured robots can easily skip a joint—or one part of the joint.

This leaves the circuit open and renders certain areas or the whole PCB non-functional. Take your time and make sure to inspect all the solder joints carefully.

### 8. Lifted Pads

Lifted pads on the solder joints occur due to either excessive force or excessive heat applied to the PCB during soldering. The pad lifts off the surface of the PCB and is a potential short-circuit hazard that could ruin the whole board. Always make sure to reattach the pads back to the PCB and then solder the components on.

### 9. Webbing and Splashes

Webbing and splashes on the PCB occur when either the board is contaminated by pollutants that affect the soldering process or by insufficient use of the fluxing agent. Besides the messy appearance of the PCB, webbing and splashes are a huge short-circuit hazard that could potentially damage the board.

### **Conclusion**

We hope that you find this guide useful and informative. If you see yourself making any of these soldering mistakes, don't get discouraged; it happens to the best. Being an expert at soldering takes time and practice, and everyone makes mistakes.

There's no sure-fire method to perfect soldering, but following these tips might help:

- Always inspect and familiarize yourself with the PCB before soldering.
- Make sure that the pads and joints are clean, free of pollutants, and ready for soldering.
- Keep your soldering iron in perfect shape, especially paying attention to the tip.
- Take your time.
- Practice, practice, practice.

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## *Massive Slowdown In 2020 VC Funding Hasn't Happened ... Yet*

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By Joanna Glasner

When crashes happen, inevitably the startup space gets hit, too. Funding slows, the IPO window closes and investors say no to bankrolling huge losses in the name of growth.

Now that stocks are officially in bear market territory, and measures to curb coronavirus have turned the biggest tech hubs into work-from-home zones, we decided to check in to see if the downturn has yet impacted startup funding totals.

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The broad finding: Not quite yet. A Crunchbase global analysis of sizable venture funding rounds (\$10 million and up) shows that reported totals are down about 11 percent in 2020 compared to the same period last year.

Overall, investors have put \$41.1 billion to work in reported rounds of \$10 million and up through March 17 of this year, compared to \$46.2 billion in the same period in 2019. Although it looks like a moderate decline, it's actually too early to tell, given that a sizable percentage of financings actually get reported weeks or months after the date they close.

This year's totals have been boosted by supergiant financings for a handful of companies, with a lot of the money going toward transportation. That includes Alphabet-incubated autonomous transportation startup Waymo (\$2.25 billion venture round), ride-hailing rivals Gojek and Grab (\$1.2 billion and \$856 million, respectively) and electric aircraft developer Joby Aviation (\$590 million).

Major funding recipients in sectors other than transport, meanwhile, include plant-based meat producer Impossible Foods (\$500 million), banking upstart Revolut (\$500 million) and data warehousing provider Snowflake (\$479 million).

Why are big deals happening in the current environment? Partly, it's because big, complicated private financing rounds typically take weeks or months to close.

Thus, it's not entirely surprising to see some of the largest private investments getting announced over the same period that major stock indexes are posting their largest declines in years. A deal put together in a more bullish climate might be made public in a more bearish one.

Earlier indications of funding cutbacks may be more easily seen for smaller rounds at early and seed stage, when sought-after deals come together more quickly. However, this is difficult for us to track here at Crunchbase because reporting delays are also most frequent at these earliest stages. So, it's hard to determine whether a drop in funding is due to delayed reporting or fewer checks being written.

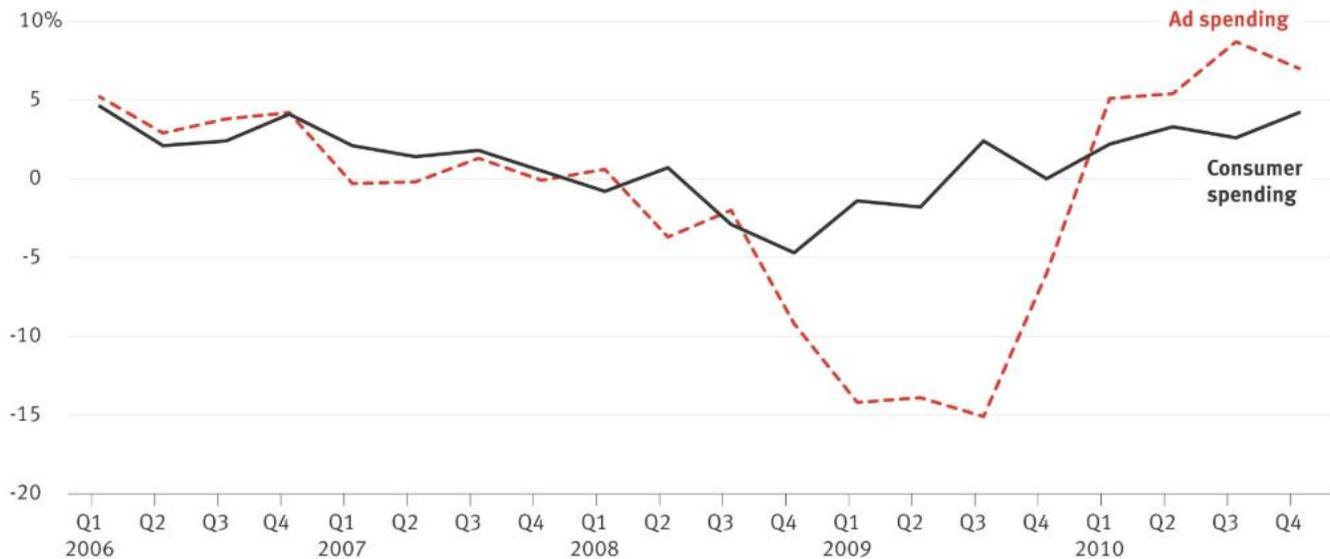
Historically, however, startup funding has trended sharply lower in recessionary times, including after the implosion of the dot-com bubble in 2001 and the financial crisis of 2008-9.

If past cycles are any guide, we can expect a sharp startup funding slowdown in coming months. We'll keep monitoring the funding totals for indications of that coming to pass.

By Alex Health and Jessica Toonkel

## Ad Downturn

How the decline in ad spending compared to consumer spending in 2008-09



Source: Kantar Media

Every quarter when Facebook reports its earnings, the social network's No. 2 executive, Chief Operating Officer Sheryl Sandberg, singles out small businesses that advertised on the platform. It's a reminder that Facebook, like Google, became a global ad powerhouse in large part by catering to small firms—a strategy that now looms as a weakness.

Over the medium term, the two companies are expected to come through any recession better than their smaller rivals, like Twitter or Snap. In the near term, however, as small businesses struggle to deal with the coronavirus-imposed economic crunch, both Facebook and Google are likely to take a hit—perhaps more than TV networks and other media firms.

“Massive cuts are to be expected,” said Brian Wieser, president of global intelligence for media agency GroupM. He added that Facebook and Google could see a more immediate impact than TV because they lean more on small businesses and it takes longer for advertisers to pull back on television campaigns. “Digital ad budgets can be cut much faster,” he said.

Google and Facebook are both “extremely exposed” to the changing fortunes of small business advertisers, according to Larry Kim, an ad tech executive who has worked closely with Google and Facebook over the years. And of the two, Facebook has more to lose from the sector, as bigger brands tend to spend more in aggregate on Google's properties, he said. Google generated \$135 billion in revenue from ads last year, while Facebook made \$70 billion. Facebook shares have fallen 27% in the past few weeks, a fraction more than Google shares and the overall market.

Facebook is responding, announcing a program this week to offer \$100 million in cash grants and ad credits for up to 30,000 small firms that the spread of coronavirus has affected. On a call with reporters Wednesday, Facebook CEO Mark Zuckerberg said the pandemic has been “a major economic shock, especially to small businesses.”

### **Widespread Impact**

Already, hotels, casinos and others in the hospitality industry have suspended all advertising, at least until the summer, according to Wil Danielson, acting head of revenue and client success at the digital arm of TV broadcaster Nexstar, which owns 432 local news sites across the country. On Wednesday, a research firm that says it represents tours and attraction firms, Arival, called for Google and Facebook to refund ad money paid in recent months, saying 28% of those firms are at risk of failure.

Some advertisers are spending more—particularly those businesses that will benefit from people staying home. Food delivery companies like Uber Eats have increased their automated digital ad buys, Danielson said. Another digital executive said that video-game companies, such as Activision and Fortnite maker Epic Games, have also stepped up ad buys.

But over the next few months, all advertisers are likely to reexamine their spending, particularly if, as is widely assumed, the economy goes into recession. History shows the potential impact of a downturn. In the 2008 recession, when consumer spending dropped roughly 5%, ad spend fell around 16%, according to data from the U.S. Bureau of Economic Analysis and Kantar Media.

That slump helped speed a shift among marketers to digital ads, then seen as offering a more reliable return on investment. Spending on digital advertising fell just 3% in 2009, while newspaper advertising dropped 20% and TV fell 10%.

The landscape is very different today. Digital now accounts for more than 50% of all ad spending, and much of that money goes to Google and Facebook, which puts them in the spotlight. But while digital advertising will be hit hard, it could still fare better than other media like TV or outdoor ads, such as those displayed on billboards, buses and transit stops.

With people stuck at home, the value of outdoor ads disappears. As advertisers shift money from outdoor slots to digital ones, Facebook and Google may benefit, said Barry Lowenthal, CEO of media buying firm The Media Kitchen. He said a financial services client recently made just that shift.

Also, as more retailers push e-commerce to potential customers, Facebook and Google are great avenues for advertising since customers can both see the ad and buy their goods online, he said.

In a note to clients last week, research firm MoffettNathanson predicted that U.S. ad spending would contract 3% this year, instead of growing 8.4% as it had previously anticipated. It forecast that digital would grow 5.8%, a much slower rate of growth than it had been expecting. But it predicted that TV ad spending would drop 7.1% instead of growing.

For another sign of what's to come, look to China, the world's second-largest ad market and the epicenter of the coronavirus outbreak that began late last year. This week eMarketer lowered its 2020 growth forecast for China's ad spending to 8.4% from 10.5%. That figure is down from a projected 14.6% increase in spend last year, and it's the slowest growth rate since the firm began tracking the region in 2011. The pullback is expected to hit print advertising in China the hardest, while digital advertisers are expected to spend 2.5% less this year, totaling \$81 billion.

### **Small Versus Big**

Last week, Mark Mahaney of RBC Capital Markets cut his 2020 revenue estimates for Facebook and Google by 5%

and 4.5%, respectively. But he cut his estimates for Snap, Twitter and Pinterest even more, by about 7%. Mahaney said in an interview that smaller ad platforms like Snap face a greater risk of losing business because spending on their services comes out of advertisers' experimental marketing budgets.

Mahaney noted that the cancellation of more world events, namely the summer Olympics in Tokyo, would change his estimates of revenue declines for the digital companies.

One outlier could be Amazon, which has built a sizable ad business over recent years and could see continued growth as sellers look to promote their products, especially for in-demand categories like household goods. But declines in some categories, like clothing, may offset the boost in others, said Adam Epstein, head of growth at Perpetua Labs, which helps companies manage their advertising on Amazon.

“Advertising and sales go hand in hand,” he said. “The extent to which advertising metrics increase is limited to the uncertainty of supply chain, operations and inventory.”

The wild card for Facebook and Google is the structure of their ad-buying systems, in which advertisers essentially compete for clicks and views through bidding. The nature of the auction technology means that if some advertisers pull back on their spending, prices could fall for the rest of the marketplace, according to Kim. While ad prices have historically gone up on the two platforms, the reverse could happen as advertisers cut spending or pause it altogether.

“This cuts both ways,” Kim said. “It’s not just a matter of advertisers dropping out and [Google and Facebook] losing that money. They lose money off the auction participants that are still there.”

Another complication is that digital media firms like Facebook and Google rely on human contractors to review some ads. Most of these contractors can’t do their jobs from home. In a blog post Wednesday, Facebook warned advertisers that its reduced, remote workforce could mean delayed review of ads and “an increase in ads being incorrectly disapproved.”

In a similar post Monday, Google said that advertisers could see delays in “some support response times for noncritical services” and that YouTube might see an increase in removal of videos due to a reduction in the number of human reviewers. Other digital media firms, like Snap and Twitter, could also face this problem.

**Rapidly advancing autonomous/ADAS technologies require more powerful GPUs to handle the load. To help mitigate costs on this front, designers are turning to virtualized GPUs to perform multiple tasks.**

By Bryce Johnstone

Over the course of decades, the graphics processing unit (GPU) has evolved from its origins as a video display adapter in arcade games to a computing powerhouse that drives artificial intelligence and machine learning, accelerating computational workloads in a wide array of fields from oil and gas exploration to natural language processing. Specifically, GPUs play an increasingly critical role in the fast-evolving technologies for autonomous driving and advanced driver-assistance systems (ADAS).

How did the GPU find its way from the video arcade to the cutting edge of scientific research and self-driving cars?

The GPU's rise as the go-to processor for Big Data workloads is due to some basic architectural differences between the traditional central processing unit (CPU) and the GPU. The GPU is a specialized type of microprocessor, originally designed for rendering visual effects and sophisticated 3D graphics for gaming, which requires intense computing power to display real-time action. To deliver that capacity, a GPU uses thousands of small and efficient cores to deliver a massively parallel architecture that can handle the processing of vast amounts of data simultaneously.

In contrast, a typical CPU consists of just few cores with abundant cache memory and is usually designed to process only a few software threads at a time. CPUs are optimized for sequential serial processing, which is sufficient for most general-purpose computing workloads. However, when it comes to simultaneous processing of vast amounts of data, the GPU wins.

A GPU with hundreds of cores to process thousands of threads in parallel has the capacity to accelerate the performance of some software by 100X compared to that of a typical CPU. And increasingly, the really challenging computational problems that we expect computers to solve for us have inherently parallel structures. Think of the enormous volumes of video-processing, image-analysis, signal-processing, and machine-learning flows that must occur reliably and in real-time to operate a self-driving vehicle. In power-constrained systems like a battery-powered electric vehicle, it's also important that a GPU typically achieves this processing speed while providing more power- and cost-efficiency than a CPU.

### **GPUs are Tailor-Made for Autonomous Vehicles**

The processing requirements of autonomous vehicles and ADAS technologies are completely within the GPU wheelhouse, especially in the areas of image analysis and parallel signal processing. Image processing is a natural problem domain for the made-for-gaming GPU. Indeed, almost any kind of computationally dense parallel computation is a good fit.

ADAS platforms can leverage the GPU's graphics compute capability to process and analyze sensor data in real-time. These discrete sensors include:

- Light detection and ranging (LiDAR), which measures the distance to a target with a pulsed laser light.
- Radio detection and ranging (radar), which is similar to LiDAR but uses radio waves instead of a laser.
- Infrared (IR) cameras systems that use thermal imaging to perceive in darkness.

These all enable ADAS to better interpret the environment and improve the system's ability to support the driver and maintain the safety of an autonomous vehicle.

As self-driving systems become more prevalent and advanced, the GPU will increase in importance—and in power. The GPU is set to be the workhorse of the autonomous vehicle, as it will be able to deliver the compute capabilities to enable cars of the future to become more aware of and responsive to their environment so that they can operate dependably, efficiently, and safely.

### Virtualizing the GPU

The level of performance demanded by ADAS platforms will require increasingly larger and more powerful GPUs, thus impacting the manufacturing bills of materials for autonomous vehicles. To mitigate this expense, platform vendors will look to increase the value and functionality of the GPU by using it to perform multiple workloads in the vehicle.

Most modern vehicles already have GPUs on-board to enable driving displays and other digital dashboards, with multiple high-resolution screens to show maps, forecasts, and other visual information. 1080p resolution is now common in mid-range cars and 4K screens are increasingly specified for luxury and executive cars.



As we've already discussed, a single physical GPU is already capable of tremendous processing performance. However, virtualizing the GPU using specialized software abstracts the processing potential of a physical GPU and transforms it into multiple virtual instances. A single physical GPU is able to host multiple virtual workloads, all operating independently of each other yet emanating from the same hardware. Virtualization lets the GPU run multiple autonomous operations, without any of the virtual instances being aware of each other or in any way affecting the others.

Virtualized GPUs have obvious applicability for autonomous vehicle and ADAS scenarios, as a single GPU can power multiple applications, from visualization of maps and operations of entertainment consoles to the processing of environmental sensor data to identify roadway obstacles.

However, enabling multiple virtual operations from a single GPU in automotive applications is only safe and effective if the GPU has rock-solid support for hardware-accelerated virtualization.

Virtualization software is most dependable when hardware enforces entirely separate managed address spaces for each virtual instance, and enables the restart, or flushing, of an instance that's not operating correctly. This workload isolation is key to allowing shared use of the GPU, while keeping critical software, such as driver-assistance systems, from being corrupted by any other process.

Imagine a situation where a problem with the dashboard software was able to affect the correct operation of the drive-assistance system—it would have disastrous consequences. Hardware-supported virtualization for GPUs provides protected execution contexts to ensure that this situation doesn't arise.

From an ADAS platform developer's point of view, hardware-based virtualization offers another additional benefit. It enables a safer environment to deliver various applications and services without any concerns about the electronics systems being taken down by a rogue piece of software. It also means that rather than a traditional hardware box with fixed software for the infotainment and engine management systems, the car becomes a flexible, configurable software platform that can be updated over-the-air. It enables OEMs to swap paid-for services in and out easily, without disrupting the car's operation, thus offering potential new revenue streams.

### **Imagination's GPU Solutions**

PowerVR GPUs developed by Imagination address the data processing and trusted architecture challenges that face developers of autonomous-vehicle platforms. PowerVR GPUs support full hardware virtualization, completely isolating virtual instances that share the GPU. They also provide the muscle required to manage and prioritize these virtual operations to effectively power the ADAS platform architecture, with the performance bandwidth demanded to achieve safe, dependable outcomes.

Lower power consumption is also critical for autonomous vehicles, as most self-driving cars will be electric and operate on batteries. Lower power requirements for the vehicle control computing platform help lead to improved overall vehicle performance.

The core compute architecture inside PowerVR GPUs was designed from the ground up to offer fast performance and low power consumption through reduced-precision computation, especially half-precision floating point (FP16). Running at lower precision (where lower is usually classed as less than 32 bits) is one of the best ways to reduce power dissipation in an embedded GPU without significant loss of accuracy.

Imagination designed the FP16 hardware as a separate data path from the full-precision FP32 hardware. Though shared data-path designs are common since they're simpler in many ways, having discrete hardware for each pathway enables the company to offer the best possible power consumption and efficiency as each data path accepts fewer design compromises to do what it needs to do.

Imagination also offers a toolset to support the development, optimization, and deployment of neural networks across GPU and AI accelerators. The design environment provides a single unified tool-chain that lets developers take multiple frameworks and multiple network types and bring them into a format that allows them to be deployed on:

- The GPU as a compute engine.
- The PowerVR Series2NX and Series3NX neural networks accelerators.
- A mixture of the above two, where the flexibility of the GPU to implement a new network layer can be complemented by running the remaining layers on a highly optimized, high-performance dedicated convolutional-neural-network (CNN) accelerator.

According to Imagination, ADAS platform designers can trust PowerVR GPU as a proven component in the overall system architecture of the autonomous vehicle, with best-in-class power efficiency and memory bandwidth usage, as well as a balanced GPU design that fits well with the car's technology needs.

These include improved performance for the systems that the driver and passengers interact with most—on larger and higher-resolution displays—and with a design that lends itself to safer, more dependable next-generation ADAS applications.