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 CB DIGEST also reports on what the smartest people are saying about the world.

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Microsoft posts $35B in revenue, up 15%, sees 'minimal net impact' from COVID-19 in quarter
Microsoft reported $35 billion in revenue, an increase of 15% from a year ago, as increased demand for its productivity, gaming and cloud technologies overcame the COVID-19 pandemic's impact on its Windows PC and advertising businesses. The company posted profits of $10.8 billion, up 22%, translating into earnings per share of $1.43, topping Wall Street expectations by 17 cents.

Alibaba operates 10 data centers in China and 11 more internationally
In response to the ongoing COVID-19 pandemic, which has heightened demand for cloud computing services and technology, Chinese company Alibaba revealed that it will invest 200 billion yuan ($28.26 billion) in its cloud computing division over the next three years. Specifically, the company said that the funds will go towards

SBA System Crashes With Rush of Emergency Loan Applications
Shortly after the Small Business Administration began accepting applications for round two of its emergency loan program, the computer system processing the applications crashed, The New York Times reports.

The Senate last week approved more than $320 billion in new funding for the Paycheck Protection Program, an SBA initiative to provide small businesses across the U.S. with short-term loans, after the first round of funding quickly dried up. Funds are allotted on a first-come first-served basis, so borrowers are racing to banks and lenders to get their applications filed as soon as possible. The SBA must approve each application through its antiquated loan processing system known as E-tran.

Argo.ai Keynote on SWIR SPAD LiDAR
IEEE International Conference on Computational Photography (ICCP 2020) publishes Argo.ai Mark Itzler's keynote about automotive SWIR SPAD-based LiDAR "Single-photon LiDAR Imaging: from airborne to automotive platforms." Argo.ai got into LiDAR business through the acquisition of Harris spin-off Princeton Lightwave in 2017.

Fibocom Modules Used to Conduct their First Data Call on China Mobile's Standalone 5G Network
Fibocom, a provider of cellular embedded wireless module solutions for the IoT, has announced that its 5G modules FG150 and FM150 have completed the first data call and end-to-end data transmission services on China Mobile's Standalone-Structured 5G network. The download rate on this network exceeds 100 Mbps. Fibocom FG150 and FM150 5G modules are the first 5G modules based on the Qualcomm SDX55 platform to offer the data transmission services under the SA-structured 5G network in China.

Wireless modules are essential for communication between IoT terminals and the base stations. As a leading IoT wireless module solutions provider, Fibocom's 5G modules have achieved another R&D milestone in the industry. The completion of the first data call under SA-Structured 5G network is a significant step towards the realization of all the three 5G features (eMBB, uRLLC, mMTC) and helps customers to accelerate the large-scale deployment of industry applications based on 5G.

Nokia secures $1 billion 5G deal with Bharti Airtel
Nokia has secured a $1 billion (nearly ₹7,636 crore) deal with India's Bharti Airtel to supply its Single Radio Access Network (SRAN) solution across nine geographic regions in India. In a process that is expected to be completed by 2022, Nokia will deploy 300,000 radio units across several of the carrier's spectrum bands. In addition, Nokia will provide its RAN equipment, including its AirScale Radio Access, AirScale BaseBand and NetAct OSS solution. National regulators have divided India into 22 geographic "circles" for purposes of telecom maps; Nokia's equipment will be used in nine of those circles.

Google Revenue Rises 13% On Early 2020 Ad Strength
Google-parent Alphabet said late Tuesday revenue for the first quarter rose 13% from a year ago to $41.16 billion, boosted by strength in its ad business until shutdowns from the coronavirus hit in March. Still, the revenue growth was down from the 17% increase Alphabet posted a year prior.

Its net profit for the quarter rose to $6.84 billion, up just 3% from a year ago, when profits were lowered by a one-time $1.7 billion fine from the European Union over competition concerns involving Google's AdSense platform.

The company's first quarter revenues beat analysts' estimates of $40.38 billion, but its $9.87 earnings per share were below the $10.33 estimates. Alphabet's stock jumped over 7% in after hours trading. Revenue from YouTube ads rose 33% to $4.4 billion in the first quarter, while revenue from its cloud computing business advanced 52% to $2.8 billion.

With the global economic slowdown only kicking in during the last few weeks of the quarter, Alphabet sidestepped a major drop in advertising. But that's expected to change in the second quarter.

"Performance was strong during the first two months of the quarter, but then in March we experienced a significant slowdown in ad revenues," Alphabet CFO Ruth Porat said. She described it as a "tale of two quarters."

Specifically, Porat said revenue for Google Search and other advertising was up 9% from a year ago, which included two strong months followed by "a mid-teens" year-over-year revenue decline for March.

The finance chief said in the first few weeks of the second quarter there were "early signs that users are returning to more commercial behavior" on search, but that it was "premature" to gauge how that would impact its ad revenues for the current quarter. Overall, she said, "we anticipate that the second quarter will be a difficult one for our advertising business."

Zoom Video Restated User Numbers
Zoom Video stock fell 7% on Thursday after the Verge reported that the popular videoconferencing software had admitted it didn't have 300 million daily active users. Instead Zoom's service had 300 million "daily meeting participants." Zoom corrected a blog post from earlier this month that used the erroneous description.

The distinction between users and daily meeting participants is important. As The Verge pointed out, someone who is on multiple Zoom calls in the one day—as many people have been during the quarantine—would be counted separately in the "daily meeting participant" number. But they would be only counted once as a daily active user. Zoom's stock price has soared under the perception that it is the go-to source for videoconferencing, despite competition from Google, Microsoft, Slack and others. Investors may become a little more skeptical about Zoom's claims as a result of this latest report.

Airlines brace for turbulence
Worldwide, airline capacity was down 70 to 80 percent in April compared with a year earlier, and multiple large airlines have temporarily ceased operations. Overall, almost 60 percent of the global fleet was grounded. In the United States, capacity was down more than 70 percent, far surpassing the combined year-on-year declines after September 11 and the global financial crisis of 2008.

SoftBank has more bad news for shareholders
In light of steeper losses from its WeWork investment, SoftBank has again revised its annual guidance for the latest fiscal year.

The Japanese tech giant now expects a net loss of 900 billion yen (about $8.4 billion)—150 billion yen more than it announced over two weeks ago. SoftBank said its investment in WeWork, as well as its loan commitment and financial guarantee for the co-working company, was responsible for about 700 billion yen in losses.

The new guidance follows an announcement in mid-April, when SoftBank told investors it expects the value of its Vision Fund portfolio to drop 1.8 trillion yen. Earlier this month, WeWork sued SoftBank, its largest investor, for backing away from a $3 billion tender offer that SoftBank said would primarily benefit founder Adam Neumann and fellow investor Benchmark.

Many SoftBank-backed companies showed signs that they were struggling before the coronavirus pandemic; the crisis has only exacerbated those problems. In recent months, real estate tech startups Opendoor and Compass, construction tech provider Katerra and restaurant robot-maker Zume have each reportedly laid off hundreds of employees. And internet satellite company OneWeb has filed for Chapter 11 protection.

Tesla stock drops after Elon Musk's confounding tweet

Following a stellar earnings report from Tesla, in which its earnings per share soared above analyst bets, Tesla's stock rocketed to a monthly high on Wednesday. CEO Elon Musk, who has apparently had his fill of Earth-shattering successes, decided to snuff out the rise.

"Tesla stock price too high imo," the billionaire mogul tweeted Friday.

Influential as always, Musk cut his own stock down 12% in less than an hour. (It's now sitting at a cool 9% under yesterday.) Mission accomplished. Musk's head-scratching tweets in the last week have included musings on the "moral arbiter of the world" and a crusade to "FREE AMERICA NOW" from the coronavirus lockdowns that are currently saving countless lives across the U.S.

Two hours ago, he tweeted, "I am selling almost all physical possessions. Will own no house," followed by a rendition of "The Star-Spangled Banner." The stream of extra-baffling blubber raised suspicions that Musk's account may have been compromised, although his typical chatter is odd enough that it's hard to tell.

We reached out to Tesla for comment and will update this post if we hear back.

Regardless, Musk is flying high these days. Yesterday, NASA announced it had selected his aerospace manufacturing company, SpaceX, to design a lunar landing system to drop astronauts on the moon in 2024. Fellow tech titan Jeff Bezos also received a contract for his company Blue Origin, while aerospace giant Boeing was left out of the deals.

Andreessen Horowitz Raises $515 Million for New Cryptocurrency Investments
Venture capital firm Andreessen Horowitz has secured $515 million for its second cryptocurrency and blockchain fund, the firm announced this morning (April 30, 2020). Led by partners Katie Haun and Chris Dixon, the firm's first crypto-focused fund raised $300 million in 2018. A16z was early among institutional funds to make cryptocurrency investments, and has taken stakes in digital currency trading platform Coinbase and crypto security business Anchorage, among others. The firm is also a founding member of Facebook's digital currency project Libra.

Nvidia completes acquisition of Israel's Mellanox for $7 billion
US gaming and computer graphics giant Nvidia Corp. on Monday announced the completion of its acquisition of Israel's Mellanox Technologies, Ltd. for a total of $7 billion. The acquisition, initially announced on March 11, 2019, "unites two of the world's leading companies in high performance and data center computing. Combining NVIDIA's leading computing expertise with Mellanox's high-performance networking technology," Nvidia said in a statement. The move will enable customers to achieve higher performance, greater utilization of computing resources and lower operating costs.

Biotech startup Erasca raises $200 million Series B funding to fight cancer
Erasca, a San Diego, California-based biotech startup on a mission to eradicate cancer, today announced the completion of a $200 million Series B funding to support the clinical development of multiple promising oncology programs and further advance the company's in-house drug discovery pipeline. The round, which brings Erasca's total funding to more than $260 million, was co-led by ARCH Venture Partners and Cormorant Asset Management, with participation from new and existing investors.

Founded in 2018 by Jonathan Lim, Erasca, mission is embedded in our name: To erase cancer, is a developer of oncology drugs intended provide precision oncology options. The company's drugs are being developed through multiple discovery programs for undisclosed targets that are biological drivers of cancer and is pursuing additional opportunities for pipeline expansion through academic and biopharmaceutical collaborations, providing patients with new potential solutions to not just treat but cure cancer.

OMERS Ventures announces a new $750M fund for investing in North America, Europe
OMERS Ventures, the venture capital arm of the Ontario Municipal Employees Retirement System (OMERS), has put together a new, $750 million fund to invest in both Europe and North America. The capital vehicle is larger than the group's preceding European and North American funds combined. In 2019 OMERS Ventures announced a €300 million fund Europe-focused fund (TechCrunch covered its launch here), and the venture group's last North American fund was worth $300 million back in 2017. The new $750 million is a hybrid, acting as both the firm's Europe-focused capital pool and the source of funds from which it can invest in North American startups.

According to Damien Steel, a managing partner at OMERS Ventures, the firm invested about CAD$100 million from the original Europe fund, with the rest now reserved for follow-on investments. But the remaining differential is somewhat immaterial as the venture collective has a new, three-quarters-of-a-billion-dollars capital pool to put to work. According to Steel, OMERS Ventures has "consolidated [its] efforts and made a new transatlantic fund." The firm's hope is that the shared capital will lead to a more cohesive investing group than having two funds for different teams engendered. OMERS Ventures expects to deploy around $200 million a year across Europe and North America, a pace that Steel says will be similar to preceding efforts.

Virtual healthcare startup Medici raises $24M as telehealth surges during pandemic
Virtual healthcare startup Medici Technologies LLC said today it has raised $24 million in a new round of financing.

The money will be used to expand the company's virtual healthcare platform at a time when its offering is rapidly growing in popularity thanks to the coronavirus pandemic. The Series B round was led by Medici's current investors, which include Barry Sternlicht, chairman of Starwood Capital Group; Howard Jenkins, founder of Publix; Kenneth Griffin, chief executive of Citadel; and Nathan Kirsh, head of Jethro. Medici sells a virtual healthcare platform, compliant with the Health Insurance Portability and Accountability Act, that enables patients to meet their physicians virtually over the internet. The platform uses a private, secure connection for its video conferencing and messaging tools to ensure patient confidentiality at all times, and comes with additional patient management features for healthcare professionals that can be access from any device. The company also offers up to $1 million of malpractice insurance coverage to help reassure patients of the quality of care it offers.
Medici said the telehealth industry is being transformed by the coronavirus outbreak, leading to a massive jump in virtual visits to the doctor. Indeed, the company said it expects virtual healthcare visits to top 1 billion by the end of the year as a direct result of the outbreak, which has forced millions of Americans to stay at home for all but essential trips outside. Already, the company has seen new patient registrations increase more than 15-fold from February to April.

Rapid7 is acquiring DivvyCloud for $145M to beef up cloud security
Rapid7 announced today (April 28, 2020) after the closing bell that it will be acquiring DivvyCloud, a cloud security and governance startup, for $145 million in cash and stock. With Divvy, the company moves more deeply into the cloud, something that Lee Weiner, chief innovation officer, says the company has been working toward, even before the pandemic pushed that agenda.

Like any company looking at expanding its offering, it balanced building versus buying and decided that buying was the better way to go. "DivvyCloud has a fantastic platform that really allows companies the freedom to innovate as they move to the cloud in a way that manages their compliance and security," Weiner told TechCrunch.

Tecton.ai emerges from stealth with $20M Series A to build machine learning platform
Three former Uber engineers, who helped build the company's Michelangelo machine learning platform, left the company last year to form Tecton.ai and build an operational machine learning platform for everyone else. Today the company announced a $20 million Series A from a couple of high-profile investors.

Andreessen Horowitz and Sequoia Capital co-led the round with Martin Casado, general partner at a16z and Matt Miller, partner at Sequoia joining the company board under the terms of the agreement. Today's investment combined with the seed they used to spend the last year building the product comes to $25 million. Not bad in today's environment. But when you have the pedigree of these three founders — CEO Mike Del Balso, CTO Kevin Stumpf and VP of Engineering Jeremy Hermann all helped build the Uber system — investors will spend some money, especially when you are trying to solve a difficult problem around machine learning.

The Michelangelo system was the machine learning platform at Uber that looked at things like driver safety, estimated arrival time and fraud detection, among other things. The three founders wanted to take what they had learned at Uber and put it to work for companies struggling with machine learning. The company currently has 17 employees and is looking to hire, particularly data scientists and machine learning engineers, with a goal of 30 employees by the end of the year.

Israeli Startup Codota Raises $12 Million in Series A Round Led By Khosla Ventures
Israeli startup Codota Dot Com Ltd announced Monday that it has raised $12 million in series A funding led by e.ventures. Khosla Ventures, which had previously invested in the company, also participated in the round. Codota has raised a total of $16 million so far, including its seed round in 2017. Codota's developed an AI platform that provides developers with automated code suggestions. Similar to programs like Gmail's Smart Compose or Grammarly, Codota's platform completes lines of code for developers.

Catalyst Raises $25M At $125M Valuation To Grow Its Customer Success Platform

New York-based Catalyst, which has developed a customer success platform, today announced a $25 Million Series B funding round led by Spark Capital. New York-based Catalyst, which has developed a customer success platform, today announced a $25 Million Series B funding round led by Spark Capital.

Cheetah lands $36M for contactless pickup
Cheetah, a startup offering contactless pickup and delivery of food and supplies, has closed on $36 million in a Series B round led by Eclipse Ventures. The San Francisco-based company pivoted to its current business model because of the pandemic. Previously, it offered a wholesale delivery service for restaurants and small businesses.

Velo3D nabs $28M Series D
Velo3D, a Silicon Valley-based 3D metal printing startup, has raised $28 million in a Series D round that included new investor Piva. The round brings Velo3D's total funding to $138 million.

Mojo Vision raises more than $51 million Series B to fund the development of futuristic AR smart contact lens
Smart contact lenses, essentially flexible displays packed with augmented reality tech, are an obvious way to explore virtual and augmented reality (AR), and camera technologies. Mojo Vision is an invisible computing startup company that's already looking beyond that form factor with an AR contact lens. Mojo Vision announced it has raised more than $51 million in a Series B-1 investment round to propel the development of the first true smart contact lens, Mojo Lens. The round was led by New Enterprise Associates (NEA) with participation from top strategic investors and venture firms, including Gradient Ventures, Khosla Ventures, Motorola Solutions Venture Capital, Fusion Fund, and others. The new round brings Mojo Vision's total funding to date to more than $159 million. In conjunction with the funding, Mojo also announced that Greg Papadopoulos, PhD, venture partner at NEA, will join its board of directors. Papadopoulos and NEA co-led the seed round in Mojo Vision along with CEO and co-founder Drew Perkins.

Founded in 2015 by Drew Perkins, Michael Deering, and Michael Wiemer, the Saratoga, California-based Mojo Vision is a fledgling augmented reality company that develops products and platforms. Mojo envisions delivering information and knowledge that is immediate, but without the disruption of traditional devices. Mojo Lens is currently in the research and development phase and is not available for sale anywhere in the world.

Edtech startup Niche lands $35M Series C funding to reimagine and simplify the school and college search experience
Niche, a Pittsburgh, Pennsylvania-based edtech statup and a school search platform connecting people to the perfect K-12 school or college, today announced it has raised $35 million in Series C funding to advance the platform as the leading destination for users to manage their school search journey. The round was led by Radian Capital, with additional participation from Salesforce Ventures, as well as existing investors Allen & Company LLC and Tim Armstrong. In addition to the funding, Niche also announced the appointment of Weston Gaddy, Partner and Co-founder of Radian Capital, and Francisco D'Souza, Executive Vice Chairman and Co-Founder of Cognizant, to its board of directors.

Founded in 2002 by Carnegie Mellon graduates Christina Koshzow, Joey Rahimi, and Luke Skurman, Niche is a platform that helps you discover the schools and neighborhoods that are right for you. As a two-sided platform, the company currently has over 1,400 school clients including Carnegie Mellon University, Harvard Westlake School, Boston University and k12.com, and Niche will use the funding to partner with thousands of additional schools. Niche has established itself as the go-to recruiting tool for the nation's education market, particularly during this uncertain time when students and schools are exclusively online.

Utah-based seed fund Kickstart closes fifth fund worth $110M
Kickstart Seed Fund, based in Utah's Salt Lake City, has raised a $110 million Fund V it announced this morning, its largest to date. The firm's rise to investing prominence has largely coincided with Utah's own emergence as a technology hub, with the pair's success intertwined since the financial crisis when the fund was put together.

AT&T Merges Ad Tech Unit With WarnerMedia
AT&T is merging its Xandr ad tech division with WarnerMedia, but what this combination means remains to be seen. AT&T created Xandr in the hope of being able to offer very targeted advertising for both its own WarnerMedia networks, which include TNT and TBS, as well as other entertainment companies. In fact, the idea of being able to offer such targeted advertising was one of AT&T CEO Randall Stephenson's goals for buying Time Warner, now WarnerMedia. But Xandr has yet to really fulfil its promise. A few weeks ago the executive in charge of the unit, Brian Lesser, departed. He was hired by Randall Stephenson, who is stepping down as CEO. Given those developments, a combination of the unit with WarnerMedia isn't surprising. The question now is how will Warner combine its ad sales teams with Xandr. Xandr overall has more than 1,000 people within the division, and given the pandemic and AT&T's need to cut costs, tough decisions are likely.

All of this will be up to Jason Kilar, who starts as WarnerMedia CEO tomorrow and his new boss John Stankey, who is taking over as AT&T CEO, replacing Stephenson. Given WarnerMedia's focus on its upcoming HBO Max streaming service and its plans to introduce a tier with limited ads next year, the company may decide to just focus Xandr's tech on its own needs.

ASAPP raises $185M for customer service
Artificial intelligence customer service startup ASAPP received $185 million in a new round of funding, bringing total capital raised to $265 million. The New York-based company's AI technology helps customer service agents determine best responses in real time when helping a customer over the phone or through messaging.

Procore pulls IPO, raises $150M
Construction management software provider Procore Technologies has put off its plans to go public in favor of raising more funding. People familiar with the decision said that Procore has closed on more than $150 million in funding at a valuation of about $5 billion.

Dascena secures $50M to improve patient outcomes
Dascena, a machine-learning diagnostic algorithm company, has closed on a $50 million Series B round led by Frazier Healthcare Partners. The Oakland, California-based company targets early disease intervention, with the aim of improving patient care outcomes.

Goldman's Top Tech Banker: Here Come the Debt Deals

By Cory Weinberg

Nick Giovanni. Photo courtesy of Goldman Sachs

Six weeks ago, Goldman Sachs' tech bankers were preparing Airbnb for its stock-market debut. Investors in the travel firm would be able to sell their shares on an open market, providing a clear window into what Airbnb was worth. Instead, as coronavirus halted travel around the world, Airbnb's revenue began evaporating. The company enlisted its bankers, Goldman Sachs and Morgan Stanley, to help raise $2 billion of debt, at high rates.

Among private tech companies, Airbnb is an outlier so far. Few have turned from the equity markets to debt investors during the pandemic. Nick Giovanni, a top Goldman Sachs tech banker, expects that to change soon. But he cautioned that future deals for private tech firms might look different from the deal Airbnb struck. Instead, he anticipates a rise in private convertible debt, where lenders are able to convert their loans into equity down the road.

"There are lots in the works," he said in an interview, declining to identify the deals.

Private tech companies typically have a harder time borrowing money from traditional lenders than public firms do, Giovanni said, because they don't have the cash flow to borrow against and they lack credit ratings. They usually have to pay higher interest rates and have smaller pools of potential investors. Often that leaves convertible loans as the only option. In convertible deals, investors can buy shares in the company's next financing or initial public offering, typically at a 10% to 25% discount.

The likelihood that more private firms will raise convertible debt reflects the uncertainty many startups and investors are facing. Few firms will be able to raise money at higher valuations in the near term, a stark change from the pre-coronavirus funding environment many saw as frothy. The median pre-money valuation for late-stage startups soared from about $45 million in 2016 to $80 million in 2019, according to PitchBook.

"Most public company valuations have decreased, and those are key reference points for late-stage [private] valuations," said Giovanni.

Deals for Snap, Slack

While the lending environment for private firms is challenging, public companies are encountering an improving market for debt deals, aided by a Federal Reserve bond-buying spree.

Snap on Thursday said it would raise $750 million in convertible notes to bolster its cash reserves, a day after it announced better than expected earnings. CEO Evan Spiegel called the move "opportunistic capital." Slack, which has seen a boom in business coming from people working from home, raised $750 million in convertible notes earlier this month, at a 0.5% interest rate. Goldman Sachs works with both firms.

One advantage of convertible debt for public companies is that it won't convert to equity unless the stock has risen significantly.

"More companies need it now than they thought they did a few months ago," Giovanni said.

Investors who buy a private company's convertible debt get interest payments—typically 5% to 8%, accruing in shares rather than cash—as well as downside protection. The debt holders get paid back before other investors in the event of a liquidation. This type of financing works best for companies that want to avoid investments at a lower valuation and expect to see a return to high valuations, said a venture capitalist involved in potential convertible debt investments.

Private companies that are closer to going public rarely raise convertible debt, Giovanni said. One exception is Uber, which raised $1.5 billion in convertible debt in 2016, in conjunction with a more highly valued equity funding. Another recent example is e-cigarette maker Juul, which has raised about $1.5 billion in convertible debt over the past year as its value has plummeted due to regulatory issues.

Giovanni said investors can offer "flexibility on structure" for convertible debt, meaning companies can negotiate interest payments and conversion prices before closing the deal. Debt is "slightly more expensive than it was a couple months ago, but it might be cheaper than selling equity at a discount to where you used to be valued," he added.

Deals Under Duress

Troubled startups including scooter firm Lime have been discussing more painful financings, such as a deal that would cut Lime's valuation by 80% and push down the value of each investor's stake. Several venture capitalists said other firms are considering equity deals that would give much more power to preferred investors versus common shareholders like employees. Those powers include "liquidation preferences" that would give investors certainty they can double their investment. Investors sometimes try to negotiate those terms into convertible debt deals, another venture capitalist said.

Some large startups that have continued to thrive during the Covid-19 crisis have raised equity at higher valuations in recent weeks. These include collaboration software firm Figma, payments firm Stripe and valuation software startup Carta.

Venture-backed startups increasingly have borrowed from banks and specialized debt funds in recent years. Now, some of those lenders might retreat or add more onerous conditions when lending to early-stage startups, according to a recent PitchBook report.

Giovanni said he doesn't expect many large private firms to be able to raise secured debt, as Airbnb did. Giovanni declined to discuss the Airbnb deal in detail. Others close to the company said the travel firm talked to investors about raising convertible debt, but didn't want to give up as much equity as investors wanted.

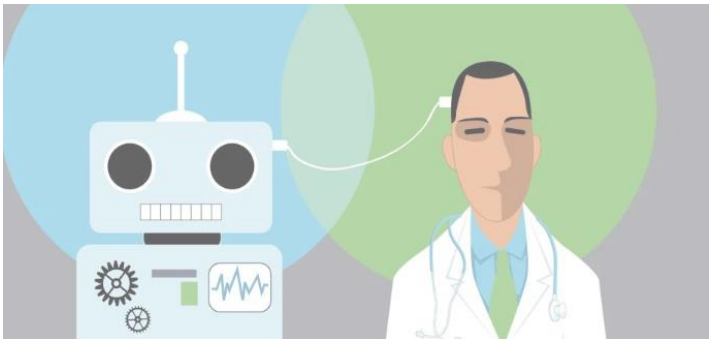
Instead, it turned to private equity firms, which are more willing to offer structured debt. Airbnb raised its first $1 billion in debt from Silver Lake Partners and Sixth Street Partners. It has to pay an exorbitant 11% to 12% interest rate on that debt, but it only hands over about 1.25% of its equity to investors through warrants (the option to buy equity). Airbnb's subsequent round of debt had an interest rate of about 8%, but didn't require it to give up any equity.

"Without the cash flow to support leverage, you have to be a large private company where the debt represents a small part of total value," Giovanni said.

Meanwhile, the markets for IPOs and mergers have mostly stalled, he said. "People just do not know how to project their business," he said. As for potential bidders, he added, "no one knows what multiple they are paying of projected earnings."

A full-time VC & part-time ER doctor shares his thoughts on COVID-19

By Natasha Mascarenhas



An **emergency room** physician for the past 12 years, Dr. Robert Mittendorff joined Norwest Venture Partners eight years ago as a healthcare investor; the firm invests in a number of healthcare startups, including Talkspace, which raised a $50 million Series D last year, and TigerConnect.

As the COVID-19 pandemic spreads, Mittendorff is spending his weekdays with portfolio companies and weekends working with Kaiser Permanente in San Francisco. While he notes that his medical colleagues are "bearing the brunt" of the pandemic by working full time, we wanted to hear from someone who has a foot in both the investing and the healthcare world right now.

In this interview, he discusses what he's learned from both roles, how it has influenced his healthcare investments, and offers his predictions regarding which companies will fare the best in the future.

This interview has been edited for length and clarity.

TechCrunch: How did you get to where you are today?
Dr. Robert Mittendorff: So, my journey to being a venture capitalist at Norwest and investing in healthcare companies as well as an emergency physician was really a parallel set of paths that overlapped and that cross every once in a while and now usually on a daily basis.

I started off life as a biomedical engineer really focused on wanting to be on the side of innovation and on the development of technologies to help human health. I knew early on that I wanted to be on the business side [of that], but it was important for me to understand and really be deeply in touch with what it was like to be a provider.

The journey started out going to engineering school, medical school, and then business school in the middle of medical school. I trained at Stanford, which really exposed me to county hospitals, which are probably going to be the more challenging situations as the weeks go on here, and then to Kaiser Permanente. And then, of course, Stanford, I was exposed to San Francisco General and then the Santa Clara Valley Hospital. I always practice part-time following up so it's been 12 years as an attending, practicing part-time as an emergency physician.

In the venture space I saw an opportunity to really help select entrepreneurs and markets to grow them to a higher impact state.

Can you tell me a little bit about how your hospital shifts have helped influence investment decisions or just your perspective in general?
The part about practicing is that it keeps you a little bit more practical when you think through how technologies are adopted. I was involved informally in marketing robots that cost about a million dollars to hospitals. We sold a little over 100 of those globally. So I'm very intimately involved with how hospitals think about consuming innovation and adopting it and deploying it. It's the basic knowledge and experience as a physician, it's the hands-on experience and the time I've spent as an operator selling to hospitals that gives me a lot of perspective right now. And I have to admit, I am utterly impressed at how amazing the U.S. health system, and the hospitals in the U.S. system are

working to solve this. And for the last month, largely on their own with very little, if anything, federal support or leadership.

What have you been seeing on the ground during your shifts?
We are preparing the capacity for what we know is coming, which is a growing number of cases with a growing severity of respiratory symptoms in the coming three to four weeks. So that's what we're seeing. I've been just amazed that the doctors and nurses, I mean, these are largely voluntary professions. But all these people took an oath, and they're all showing up for work. And they're doing amazing jobs. And I'm sure they will continue to do that in the next month or two.

I'm imagining your day-to-day must be emotional right now.
Well yeah, I think it is for all the doctors right now. Certainly my friends in New York that are not living with their families.

I have a seven-year-old daughter and she's out of school right now and, you know, I've made the decision after a long amount of thought about it that I will be around her during this time. But I am obviously very careful during my shifts. But I think yeah, there's a lot of challenges personally and professionally. I do have to say it's been amazing to see that, for the most part, people are following the government's recommendations to quarantine, which definitely, I think, will have a major effect here.

The level of innovation I'm seeing in every company as they try to think through, can they do something to help? Is there a way to create a product or service to help? Can they donate, can they mobilize, is, you know, very inspiring from an American capitalist point of view. I think California's leadership has been stellar on the state level, but in the absence of federal leadership until like the last two weeks, it is an amazing thing to watch. We have mobilized the most creative country, I think, on the planet and we are getting true innovation out of this. It is not without our challenges in the coming weeks or months, but I wouldn't want to be anywhere else in the world, frankly, right now and dealing with this.

I'm happy to hear that. It is inspiring to see everyone raise their hands in Silicon Valley and help, even if they aren't forced to.
I think most entrepreneurs in Silicon Valley and in healthcare tech are entrepreneurs that are trained to be mission driven. And this is just another mission for them. So I think what we're seeing, we probably won't see this across the U.S. We're seeing it in a lot of areas. But certainly in Silicon Valley, almost every one of our companies is thinking about not how this will affect them, but then how can they help directly or indirectly develop a service that could help in any aspect? Because it's obviously not just the healthcare problem, it's clearly an economic problem. It will be a social problem, as well. So it's very inspiring.

What are you telling your portfolio companies right now in the healthcare space?
I think each one is different. A month ago we said, you know, every one of our companies needs a two-year plan that incorporates how COVID will affect their business, positively or negatively. How will it affect revenue? How will that impact the cost of goods?

I think some companies will have headwinds during this time. For example, if you're providing a service to employees that are expected to be on-site, that's going to be challenging right now. However, a number of our other companies, I have a company that literally their software platform is used by hospitals for the development of patient-flow practices and to manage search capacity. So they already had a platform. It's in 60 hospitals. They've built a free COVID model.

And so I think the point of healthcare companies rolling out new initiatives is not for PR, or to kind of like convince the public the point of the business, but it is actually to help hospitals operationalize when their demand will hit and be ready for it. Because it takes a couple of weeks to put the logistics and supply chain into place.

I've heard often that it is hard to adopt technology in hospitals because the tech prices are high and hospitals already have strict budgets. And I just wonder from your end what your thoughts are on adoption?
I think if you're relevant in this situation with COVID-19 to a hospital I think there is an opportunity to help out and have impact. If what you're trying to sell a hospital right now, for example, is something that has to do with elective procedures for example, you're probably not going to get an audience because most hospitals are not performing elective procedures right now. Again, it's very bespoke, it just takes some nuance. I think, if you require a lot of integration for your product and you're not already in hospitals, it might be challenging for a while, because frankly, all hands are on deck for COVID-19 in most urban areas right now. And that's what CEOs are thinking about.

From the telemedicine side, are you feeling more hopeful for it given the rapid implementation of it during this time period? Equally as hopeful from before?
Telemedicine I've always been bullish about, if used properly. This pandemic is the single, you know, biggest driver of the intelligent use of telemedicine since telemedicine was invented. And I think what we will see is that physicians and patients and nurses are adopting telemedicine because they still have to treat human disease in the midst of a pandemic. And telemedicine is a wonderful set of technologies to do that with. I think that once we have shown that we can do that for a variety of different conditions, we will have a hard time going back to bricks and mortar. I would just liken it to Amazon purchases. We'll never go back. Once you figure out that, hey, you don't actually have to go to the store to buy razor blades.

You said you like telemedicine if it is used properly. What is the wrong way to use telemedicine?
An abuse of telemedicine is when you are trying to diagnose or treat a disease that requires a physical exam without a physical exam. For example if you have an ankle injury and my telemedicine consult is by phone without even video, that is the wrong use for telemedicine.

To close, what is your best advice for startups more generally right now trying to grow in this environment?
My best advice is to make sure that your business plan is relevant in the pre-COVID world, and also relevant in the post-COVID world. And what I mean by that is, you know, there will be changes in business, but we'll return to some extent to where we came from. But what can be virtualized in business will be virtualized during this time and many things will probably stay that way. E-commerce will become even more prominent. We'll see things like purposeful socialization and purposeful experiences instead of people entering the social space without having a reason, they'll do it for purpose.

And I think we'll see all forms of training become more virtual than we probably would have seen before. So I think whatever business you have, if you can see it surviving in both worlds, or having some type of a play where it works in both worlds, I think that will make investors more comfortable than say, for example, if what you're selling is a non-essential service that has to be delivered in-person.

Indie.vc founder Bryce Roberts: Profitability is 'more achievable than a Series A round'

By Megan Rose Dickey

Despite all evidence to the contrary, there's more to building a startup than raising venture capital.

Founders are finding success without overly relying on VC dollars; some are even sharing profits with their respective employees and customers without the help of traditional funding and Silicon Valley power dynamics.

As some investors slow down their funding pace, it has become clear that profitability trumps funding and venture capital can only take a startup so far when the economy tanks and outside cash streams dry up.

In the Indie.vc portfolio, profitability is its driving force. In fact, its main criterion for funding is that a startup must be on a clear path to profitability with durable fundamentals like high gross margins or the ability to start charging for a product right away, as opposed to companies that need a significant amount of upfront investment for research and development.

Profitability, Indie.vc founder Bryce Roberts tells TechCrunch, needs to be a habit, and founders need to recognize that it's not a switch they can just turn on. Startups looking to prioritize profitability need to start out as revenue-driven businesses that replace funding milestones with profitability goals.

"Genuinely, it's not rocket science," he says. "Profitability isn't this crazy, elusive thing. It's literally more achievable than a Series A round. It's way more achievable than a Series B round. If you look at the kind of fall-off between those rounds, most entrepreneurs would be better off finding their path to profitability and scale."

Indie.vc, which recently announced its latest batch of investments, advises founders to make sure they have what they need to be stable and then to create and measure value, Roberts says. That value, which differs depending on the company, must be quantifiable as some metric or revenue.

To do that, Roberts says founders should adopt a mindset where they're focused on creating revenue opportunities, rather than cost savings. Indie.vc's model also does not prioritize hiring ahead of growth, a strategy that seems to be working for its portfolio during the pandemic.

"When I look at the layoffs across our Indie.vc portfolio, they're relatively small," he says. "Our companies are probably doing more hiring than firing right now just given that a bunch of them are seeing a lift in this market."

Roberts is a proponent of raising money on your own terms, not raising for the sake of trying to pivot into a business that investors are willing to fund — and then consequently setting yourself up to need venture capital as a lifeline.

"I think that goes on a lot out there these days," he says. "We have this notion of what we call permission-less entrepreneurship. If you have to ask people for permission to exist, and the more you rely on those people for yourself to exist, the more risk and exposure you have."

Still, sometimes startups need funding, which is fine, but there are other options that exist between bank debt and equity financing deals. Indie.vc, which doesn't take any equity upfront, is one such alternative. If a startup in its portfolio raises additional money or sells, Indie.vc converts its investment to equity at a percentage decided on by the company. If the company never sells or never raises another round, Indie.vc gets a share of the company's revenue until the firm makes 5x its investment.

But Indie.vc isn't the only alternative in town, and Roberts recognizes that. He says he has begun to offer additional resources to startups looking for other types of funding options. Through its free product, Intro, Indie.vc outlines a number of alternative models.

For example, revenue-based financing lets a company use its existing revenue to finance a loan. According to Indie.vc, this type of financing is good for companies with high gross margins and predictable recurring revenue. Another is e-commerce financing, which can be good for companies with strong customer acquisition channels. Indie.vc explored more of these options in a webinar last week, which you can check out here.

"One of the beliefs we had early on with Indie.vc was like, entrepreneurs are just going to go look for a different product. So many of them have been basically sold the same thing in venture for the last 20 years. And once you've been kicked out of your company before, or once you've sold your business for $100 million and didn't make anything, you're going to start looking for other ways to get supported."

Secret to Snap's Recent Success: Discover and Direct-Response Ads

By Tom Dotan

In late March, a week or so after Snap stock had plunged to as low as $8—half where it was trading a month earlier—CEO Evan Spiegel reassured employees. His message was that the company was well positioned to weather the downturn. At the time some ad executives were skeptical, asking why Snap would be better off than other companies.

Today, the skeptics are quiet. After strong first-quarter earnings, Snap stock has regained all the ground it lost through the sell-off. One major reason is a surge of audiences for Discover, a feature of the Snapchat app that for the past few years had likely been an afterthought for investors and even users. Carrying short news programs produced by media companies, Discover is winning over audiences keen for information about the coronavirus.

NBCNews, which runs the news program "Stay Tuned" for Discover, says traffic is up 75% since the fall and its show has gotten more than 100 million views in March. Group Nine's "NowBreaking" show has seen a 60% jump, says a company spokeswoman. The uptick has not only renewed publishers' confidence that Snap is an outlet worth working with, but is helping Snap withstand the worst of the advertising downturn now underway.

"Ad sales are healthy and both inventory and [ad rates] have been very strong," said NBC News global head of digital news Catherine Kim in an email, talking about "Stay Tuned."

In addition to seeing a boom at Discover, Snap is benefiting from its reliance on a decidedly unsexy part of the ad market—direct response ads, those commercials that try to persuade people to take some specific action. In Snap's case, these ads typically prompt people to download apps, such as those for games or e-commerce outfits. More than half of Snap's advertising revenue comes from these kinds of ads, which have held up better than other ad categories in recent weeks.

That's likely a major reason why Snap last week revealed that while its ad revenue growth had slowed sharply, it was still growing 15% for the first two weeks of April, slowing to 11% last week. That likely cheered investors, given the anecdotal evidence from other companies that suggested advertising was dropping. Investors will get a better idea of the broader digital ad market this week when big tech firms like Alphabet and Facebook report first-quarter earnings.

Another indication that demand for Snap ads has held up: while ad rates on YouTube and Facebook dropped 36% and 46% from March to April, ad rates on Snap fell only 4%, according to one media company that publishes on multiple platforms.

Rediscovering Discover

Many publishers lost faith in Snapchat's Discover after a 2018 redesign of the app that hurt traffic. Some shows got lost among a new algorithmically sorted Discover section. But the company spent part of last year reworking its algorithm to promote content viewers would find more relevant. Recently the app has given weight to shows that feature breaking news.

That helped bring back audiences well before the pandemic. "'Stay Tuned' has seen incredible growth in recent months," NBC's Kim said. "While much of that recent surge in audience was driven by [its] coronavirus coverage, it's a continuation of growth we've seen every month since the fall."

Also, over the last year, Snap has introduced new ad formats that publishers like, because those formats allow them to charge higher rates. Among the more popular ones are commercials that viewers can't skip. They have to watch at least six seconds of the ads before they can flick through them.

Snap made another nod to publishers when it quietly rolled out a new section of the app, dedicated to original shows, that lives to the right of the Discover screen. Snap produces some of those shows, like the current events show "Good Luck America," while others come from digital media companies like Group Nine.

While it's not clear yet whether this new section is drawing a lot of traffic, the fact that Snap is putting these shows in their own separate area could make it more appealing to advertisers. Other parts of the app mix a wider variety of content, which can make them less attractive to advertisers who want to know what kind of programming their ads will appear next to.

"Snap growing is amazing for us and the app focusing on new products and timely and topical news has benefits for us and the audience too," said Tina Exarhos, chief content officer at GroupNine's news division NowThis.

Early Preference

Snap's publishing resurgence wouldn't have worked if the company hadn't paired it with a successful ad strategy. But the irony of Snap's success with direct response ads is that Spiegel didn't plan things this way. When Snap first started selling advertising, he wanted to tap the highly lucrative and highly competitive television ad market which features big brands. The first ad Snapchat ever ran was for a movie trailer, and the company initially relied heavily on ads from movie studios promoting upcoming releases. But some advertisers balked about spending much on an app that mainly younger people used.

Over the past three years, the company began focusing on building the direct response ad business. By the summer of 2018, direct response advertising made up 40% of the company's revenue, and that amount has only risen since.

Meanwhile, Snap's young user base has generally made it less of a destination of major TV advertisers like auto manufacturers, travel companies and financial services—by happenstance the very advertisers that the crisis has most affected. Google, for instance, is heavily exposed to the travel industry, where advertising has collapsed in recent weeks.

Meanwhile, Twitter, which has seen an advertising resurgence in the past two years, has built its reputation in the ad world on its ability to amplify events, like the launch of a new phone or a music festival. But many of these events have either been postponed or downsized during the pandemic.

Snap hasn't given up on expanding its sales of TV-style advertising. Earlier this month the company hired Hulu's head of ad sales Peter Naylor to oversee the company's North American ads business. Over the years, Naylor has built Hulu into a substantial outlet for advertisers looking to place TV-style commercials within a digital medium. Right now, given the broader ad slump, it may help Snap to not have too big a presence in that market.

The Takeaway

Publishers on Snap's Discover section say traffic has been up in recent months, but especially during the coronavirus pandemic. That feature, as well as the company's advertising base and its reliance on direct response ads, has positioned Snap ideally for a revenue resurgence in the current crisis.

CVS and UPS team up for drone deliveries to retirees amid coronavirus outbreak

By Alan Boyle

A UPS drone made by Matternet carries a package with a CVS pharmacy in the background. (UPS Photo)

UPS' drone subsidiary and the CVS pharmacy chain say they'll start delivering prescription medicines to the nation's largest retirement community next month, using Matternet's M2 drone delivery system.

The service, approved by the Federal Aviation Administration under Part 107 rules, will be available for The Villages, a community in central Florida that's home to more than 135,000 residents. UPS Flight Forward and CVS will be authorized to operate through the coronavirus pandemic and explore continuing needs as they arise once the pandemic fades.

Physical distancing and restrictions on retail business, enacted in response to the pandemic, are bringing more attention to the potential for drone deliveries.

The UPS-CVS delivery effort follows up on a foundation that's been built over the past year, starting with UPS' transport system for medical samples in North Carolina, and continuing with UPS Flight Forward's certification as a full-fledged drone airline last September as well as its first prescription delivery for CVS in November.

California-based Matternet, which is part of the Boeing HorizonX investment portfolio, has been partnering with UPS since last year.

UPS said the ramped-up service for The Villages will address needs that have become more acute due to the coronavirus outbreak.

"Our new drone delivery service will help CVS provide safe and efficient deliveries of medicines to this large retirement community, enabling residents to receive medications without leaving their homes," Scott Price, UPS chief strategy and transformation officer, said in a news release. "UPS is committed to playing its part in fighting the spread of coronavirus, and this is another way we can support our healthcare customers and individuals with innovative solutions."

Jon Roberts, executive vice president and chief operating officer of CVS Health, noted that CVS pharmacies already offer in-store pickup, free delivery services and drive-through pickup. "This drone delivery service provides an innovative method to reach some of our customers," Roberts said.

The first flights to The Villages will travel less than a half-mile, and deliver prescriptions from a single CVS pharmacy to a location near the retirement community. Initially, a ground vehicle will complete the delivery to the resident's door, UPS said. The operation could expand to include deliveries from two additional CVS pharmacies in the area.

Separately, UPS Flight Forward is working with Virginia's Center for Innovative Technology, DroneUp and the Workhorse Group on tests designed to determine how drones can help health care professionals respond quickly to medical needs during the pandemic.

Other drone ventures are also upping their game to respond to the outbreak. Alphabet's drone subsidiary, Wing, has partnered with FedEx, Walgreens and other businesses in the Christiansburg, Va., area to deliver over-the-counter drugs as well as other items ranging from baby food to toilet paper.

"As COVID-19 has spread and families have been encouraged to stay home, we've seen a dramatic increase in the number of customers using the service," Jacob Demmitt, a spokesman for Wing, told GeekWire in an email. (Demmitt is a former GeekWire reporter.)

Over a two-week period, Wing made more than 1,000 deliveries, for Walgreens and other retailers, Demmitt said.

Amazon and Walmart are expected to play a big part in future drone deliveries, although they're not currently involved in any of the public pilot projects approved by the FAA.

Last June, Amazon Worldwide Consumer CEO Jeff Wilke said Amazon's all-electric drones would start delivering packages to consumers within months. Although the Seattle-based retail giant has continued testing its drones in a variety of locations around the globe, it hasn't yet announced a publicly available drone delivery service in the U.S.

A major AR startup stumbled, but users are flocking to the technology

By James Thorne

News that Magic Leap laid off half its staff and abandoned its consumer ambitions may sound like a nail in the coffin for the augmented reality industry.

But the most well-funded startup in the space had struggled before the coronavirus pandemic, and there are signs that demand for AR and virtual reality are growing in a world under stay-at-home orders.

"Right now, VR is having a moment. Everyone's locked in their homes," said Adam Draper, founder of Boost VC. Many of the firm's portfolio companies in the AR and VR space have seen engagements and revenues grow substantially.

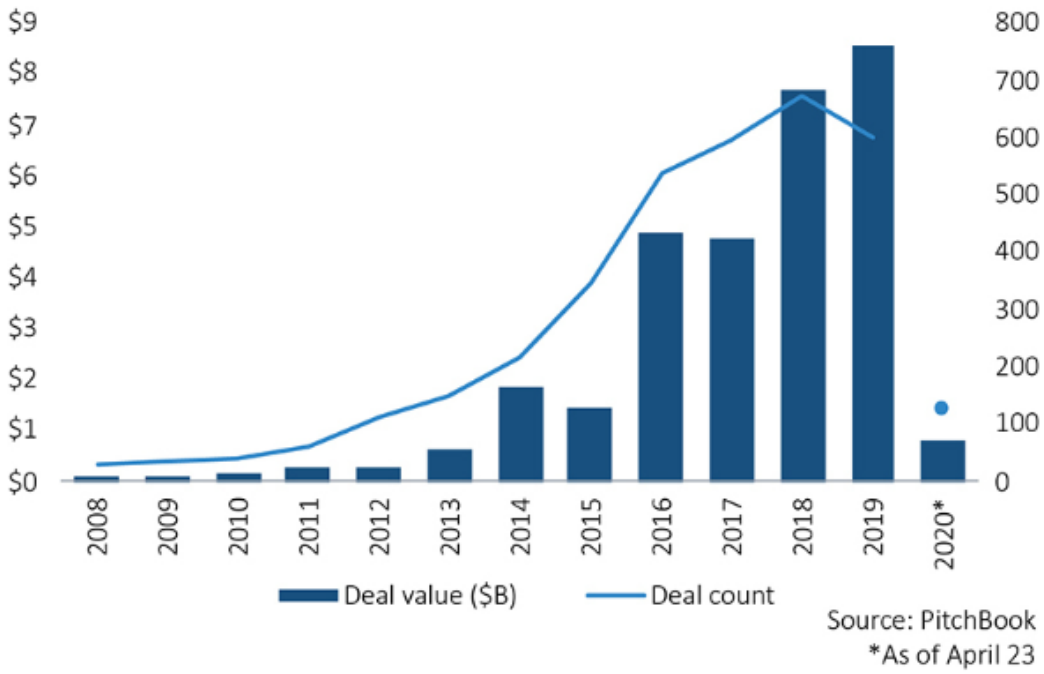
"It's starting to look like a real market," he said.

In recent weeks, artists have turned to the technology to host live concerts and music exhibitions. Commercial real estate brokers are taking clients on virtual tours of office spaces. And the tech is gaining a stronger foothold in fields like telemedicine, connected fitness and travel.

Marco DeMiroz, a co-founder of the Venture Reality Fund, said that his firm's portfolio of VR, AR and AI companies have done well overall through the first quarter, and that 10 have received or are raising new financing.

Global venture funding for VR and AR startups has been strong in recent years, with a record $8.5 billion across 600 deals in 2019, according to PitchBook data.

But the current picture is less rosy: Only 127 deals worth roughly $800 million have been announced so far in 2020.



Despite slow consumer adoption, demand is growing on the enterprise side, as companies look for ways to train people and work collaboratively in a socially-distanced environment.

"This is really the moment for VR to shine because of remote collaboration, remote training and remote manufacturing," said DeMiroz.

Telemedicine startup XRHealth raised $7 million this week for virtual clinics offering physical therapy, mental health and treatment for cognitive impairments. Since launching less than two months ago, the company has already brought on 400 providers to its network.

"We are hiring as fast as we can to support the growth," said XRHealth CEO Eran Orr.

The virtual format allows providers to more accurately track the progress of their patients and aims to reduce costs. Patients who seek treatment through XRHealth interact with a provider virtually and may perform sessions on their own through the VR app. They can either use their own headset or subscribe for access to a device.

The price point of mixed-reality headsets—$2,300 or more for the Magic Leap—could be prohibitive, even in a strong economy. But as consumers stay home more, both to avoid social gatherings and to save money, Draper thinks VR and AR entertainment could benefit from the same forces that helped Netflix add a record 15.77 million subscribers last quarter.

Due to a combination of high demand and supply chain problems caused by the coronavirus, some popular VR headsets have been out of stock in recent months. That includes Oculus Quest, which Draper compared to the original Macintosh computer—a consumer-focused hardware package that is easy to use for the average person and relatively affordable, with prices starting at $400.

"The coronavirus has created insane demand," Draper said. "The industry is not able to actually supply enough for how much demand there is."

Brain Corp Raises $36 Million to Meet Growing Demand for Autonomous Robots

Source: Brain Corp

Brain Corp *(* Chambiz DF 17 April 2017 & 11 April 2020)*, an AI company creating transformative core technology in the robotics industry, announced it has raised $36 million in Series D funding to help meet the growing demand for autonomous mobile robots (AMRs) in retail, healthcare, airports, education and other industries now on the front lines of the COVID-19 health crisis. The round was led by returning investor SoftBank Vision Fund 1, and includes new investors ClearBridge Investments, LLC and Satwik Ventures, and an additional investment from Qualcomm Ventures LLC.

"We have always envisioned a world where robots make the lives of people safer, easier, and more productive," said Brain Corp CEO Dr. Eugene Izhikevich. "Autonomous robots are playing a vital role in supporting essential businesses and their workers during this health crisis. This investment will help us continue our pace of innovation and fuel our growth as we execute on the opportunity in front of us."

Original equipment manufacturing (OEM) partners, such as Tennant Company, Nilfisk, Alfred Kärcher SE & Co. KG, Minuteman International, Dane Technologies, UniCarriers Americas and others, license Brain Corp's robotic AI software, BrainOS®, to create autonomous mobile robots that can operate safely in dynamic indoor public spaces. The new funds will be used to further expand Brain Corp's growth into new robotic applications beyond floor care, including inventory delivery, shelf analytics, and other applications that improve employee productivity, reduce costs, and enhance customer experiences. The capital will also be used to support the manufacturing and sales efforts of OEM partners in new markets, such as those in Europe and Asia-Pacific.

"Brain Corp exemplifies the innovative, market leading businesses we seek as partners," said Aram Green, Managing Director, ClearBridge Investments. "World events have brought the value of automation sharply into focus, and we see Brain Corp playing an integral role as market adoption for robotics accelerates."

Retailers significantly ramped up their use of robotic floor scrubbers as the COVID-19 outbreak grew this year, highlighting the strong value that robotics can deliver. Autonomous usage of BrainOS-powered machines in retail locations in the U.S. spiked 13.6% in March 2020, compared to the same month last year, and 13% during Q1 of this year, according to internal network data. In addition, BrainOS-enabled robots are on track to deliver more than a quarter million hours of work over the next 30 days, giving essential workers time back to focus on other important tasks.

Working with OEM partners, Brain Corp has deployed or enabled more than 10,000 robots, one of the largest indoor fleets of its kind operating in public spaces. Customers include several Fortune 500 brands, including Walmart and Kroger, as well as Giant Eagle, C&W Services, Simon Property Group, and dozens of other grocers, retailers, airports, educational institutions, and others.

BofA Securities acted as placement agent for the company.

About Brain Corp
Brain Corp is a San Diego-based AI company creating transformative core technology for the robotics industry. Brain Corp's comprehensive solutions support the builders of today's autonomous machines in successfully producing, deploying, and supporting robots across commercial industries and applications. Named the world's top autonomy solution provider by ABI Research, Brain Corp is funded by the SoftBank Vision Fund and Qualcomm Ventures.

DHL deploying hundreds of Avidbots' Neo cleaning robots

DHL is deploying Avidbots' Neo cleaning robots at warehouses, hubs and terminals worldwide. | Credit: Avidbots

By Steve Crowe

DHL is scaling up its robotic workforce. Last month it announced an expanded roll-out of Locus Robotics' autonomous mobile robots, and today it said it's scaling the use of Avidbots' Neo floor-scrubbing robot.

Avidbots *(* Chambiz DF 27 April 2019)* and DHL first started working together in North America in 2019. DHL will now install Neo robots in warehouses, hubs and terminals worldwide. When asked to specify how many Neos will be deployed, an Avidbots spokesperson would only say the number will be "in the hundreds." The deployments will take place over the next 18-24 months, and each DHL warehouse requires only one Neo.

"DHL's strong vote of confidence in the Neo floor-scrubbing robot is a testament to the hard work the entire Avidbots team has put into building the world's only fully-autonomous floor-scrubbing robot," said Faizan Shiekh, CEO and Co-founder of Avidbots. "We're thrilled to expand our partnership to deploy Neo robots in DHL warehouses on every continent."

Here is a video The Robot Report took of a Neo operating inside a DHL warehouse in Chicago: https://www.youtube.com/watch?v=xz8gqbQDqFI

"Floor-cleaning robots, while a simple innovation, reduces up to 80% of labor hours spent cleaning," said Matthias Heutger, Senior Vice President, Global Head of Innovation & Commercial Development at DHL. "This frees up our staff to engage in more value-adding, customer-centric work while driving our Strategy 2025 digitalization agenda forward."

Avidbots manufactures the Neo robots at its manufacturing facility in Kitchener, Ontario. The spokesperson told The Robot Report the facility is running at full capacity, with workers spaced apart for social distancing and respecting all safety and security measures.

Related: DHL Innovation Center displays state of warehouse robotics

“Avidbots has not run into any manufacturing problems as of yet, as the parts it needs are in full supply,” the spokesperson said. “It has the capacity to meet not just DHL’s need in the coming quarters, but also to meet a surge in demand it’s experiencing overall.”

After an initial facility-mapping process, Neo can autonomously clean an environment thanks to proprietary software, 3D sensors and cameras. Connected to the cloud through WiFi and 4G, Neo includes 24×7 monitoring and automatically receives software updates to add new functionality.

Avidbots said it is seeing a 100% increase in demand since before the pandemic due the robot’s ability to disinfect floors. Neo has two tanks, one for clean water and one for dirty water. The company said users can put disinfectant in Neo’s clean water tank.

Earlier in April, the Cincinnati/Northern Kentucky International Airport became the first U.S. airport to deploy Neo. Neo cleans the airport for six hours at a time, which is the maximum time it can run on one charge.

Avidbots
Avidbots provides autonomous commercial floor cleaning robots. Its offering is Neo is an autonomous floor scrubbing robot. The robot has a touch-screen interface for the user to insert commands and is equipped with cameras and sensors and uses its dynamic mapping and obstacle-avoidance technology to maneuver within the facility. It can be deployed into commercial spaces such as large commercial spaces, including airports, commercial and retail facilities, educational institutions, warehouses, and healthcare facilities. In addition, the company offers a cloud-based application that allows monitoring a fleet of Neo bots in real-time and accessing reports of every cleaning operation, including productivity metrics and sector-level coverage maps. Was incubated at HAXLR8R in Summer 2014. Series B, Total funding amount is $36M.

Industrial automation security is vital as manufacturers and critical infrastructure organizations weigh a technological reboot.

By Brain Buntz

As industrial organizations grapple with COVID-19 fallout, automation has become an even hotter topic. Experts fear, however, that the acceleration of automation could drive unforeseen consequences for organizations that don't focus on security.

"When it comes to automation and industrial control systems (ICS), there is no doubt haste makes more than waste," said Dan Miklovic, an analyst at the Analyst Syndicate. "It leads to potentially catastrophic or deadly outcomes."

Mission-critical systems in industrial facilities have traditionally relied on the close oversight of human workers because the senses were "usually the most effective way to ensure optimum uptime," Chris Catterton, director of solution engineering at ONE Tech. That is changing. Automated systems often exceed human capacity to spot machine problems. An automated system can detect when a torque value on a bolt is, for instance, a few pounds light, or hear a high-frequency bearing squeal undetectable to the human ear, Catterton said.

But being lax in terms of industrial automation security can be dangerous. Hobbyist electronics, for instance, may make automating industrial machinery simple, but such products can also provide cyberattackers with a familiar target, Miklovic said. "Plug-and-play automation solutions that are not built with security in the forefront can also open the door for a vast amount of vulnerabilities," Catterton said.

Take Care With AI Deployments, Too

There's also a risk that organizations will hastily deploy artificial intelligence (AI) as part of their automation initiative. With data science experts in short supply and many experienced industrial operators sidelined as a result of COVID-19 quarantines, there is a heightened danger of errors creeping into AI algorithms. There's a risk that "the person trying to train the system lacks critical safety information," Miklovic said.

Even in ideal conditions, developing software or AI algorithms inevitably introduces some error. One rule of thumb holds that there are one to 10 mistakes per 1,000 lines of software, as the book "The Fifth Domain" has observed. Even software for mission-critical space systems could have one to five errors per 1,000 lines of code.

With software often having millions or billions of lines of code, the need to prevent and correct bugs becomes critical. History provides examples that underscore the risk of cutting corners in industrial automation security. The Ariane 5 rocket disaster of 1996 is one such example. After software developers from the European Space Agency failed to adequately update code they borrowed from a predecessor rocket, the rocket exploded. Because the speed of the craft during the launch exceeded the bounds its software specified, the rocket self-destructed. "The cost of this software error was about $300 million," said Johannes Bauer, Ph.D., principal security advisor at UL.

Another example of costly software shortcuts is the grounding of the Boeing 737 Max in 2019. After outsourcing software development tasks to $9-an-hour engineers, the plane killed 346 people in two accidents. An automated system relying on information from a sole sensor played a role in the crashes, according to the New York Times. The cost of grounding the 737 after the two accidents is $18 billion, according to Boeing estimates.

Discriminate When Allowing Remote Access

In addition to the risks of cutting corners with software-driven automation or AI workloads, the expansion of remote access in industrial environments is another danger. "Think about using Zoom [the videoconferencing application] to have shop floor personnel communicate with a shared expert resource to diagnose a problem," Miklovic said. In such a case, a cybercriminal could steal trade secrets or product manufacturing information, he noted. The rush to enable remote operations can also prompt organizations to make control systems accessible via the public internet without appropriate security controls. The threat of doing so is "a concern for safety instrumented systems," said Mark Carrigan, chief operating officer of PAS Global. "Such systems are the last line of defense for processes operating beyond their boundary conditions, and a known attack target for malicious actors."

Remote operations also heighten the risk of phishing attempts using social engineering. Such an attack could "identify employees who are likely to have privileged access so their credentials can be exploited to gain access to control system environments through increasingly accessible remote gateways," Carrigan said.

Evaluating Threats by Sector

The rush to deploy automation and remote access won't be uniform across the industrial sector. "The most critical of critical infrastructure systems" tend to have established protocols in place, and are less likely to redefine core processes, said French Caldwell, co-founder of the Analyst Syndicate. Critical infrastructure such as nuclear power plants, oil refineries and chemical plants are less likely to be impacted by social-distancing working restrictions given exemptions for such institutions.

Critical infrastructure organizations also tend to have regulatory requirements for cybersecurity. Energy utilities, for instance, must follow cybersecurity standards outlined by the Federal Energy Regulatory Commission and the North American Electric Reliability Corporation.

At the opposite end of the spectrum is industrial infrastructure such as heating, ventilation and air conditioning (HVAC), lighting and plant systems. Such systems have been "operated and monitored remotely for decades now," Caldwell said.

Organizations in the middle of these two poles are more likely to increase automation and remote working infrastructure, according to Caldwell. "It's in the very large middle group of systems where, no doubt, there is a pandemic-led increase already in remote ICS access," he said.

The Final Word

Ultimately, each organization has to evaluate the risks and rewards of digitization and automation. The risk of moving too slowly can be a threat to an industrial company's longevity just as much as rushing a deployment. "There are many different views on what to automate, how much to automate and when to automate," said Nitin Kumar, chief executive officer of Appnomic. "Physical assets are increasingly going digital. Not having automation woven around these with an adequate digital process will create a very inefficient digital operating model."

One thing is universal: Organizations must collaborate to solve these problems. Especially during the pandemic, engineers and IT leaders "need to team up to ensure that reliability and security are aligned to both the criticality of the systems and the security risks," Caldwell said. After the pandemic subsides, organizations will have more time to review how they can expand automation and remote access of ICS systems to accommodate "both unexpected contingencies and to improve effectiveness and efficiency of day-to-day operations," Caldwell said.

From a business standpoint, organizations should consider strategies to deploy automation to enhance resilience in the face of uncertainty. "There is a lack of clarity on the duration of the shutdown and the risks posed to the workforce even if the economy migrates to a semi-open posture," Kumar said. But more certain is the likelihood shareholders will "continue to be demanding as the recovery mounts," he added.

Technologies such as automation, AI and remote access can enable industrial organizations to do more with less. Those who aim to deploy them should do so cautiously. Despite the adage of security by design, many organizations find them in a sort of continual remediation mode. “Security should be a functional requirement from the outset,” said Sean Peasley, a partner at Deloitte.

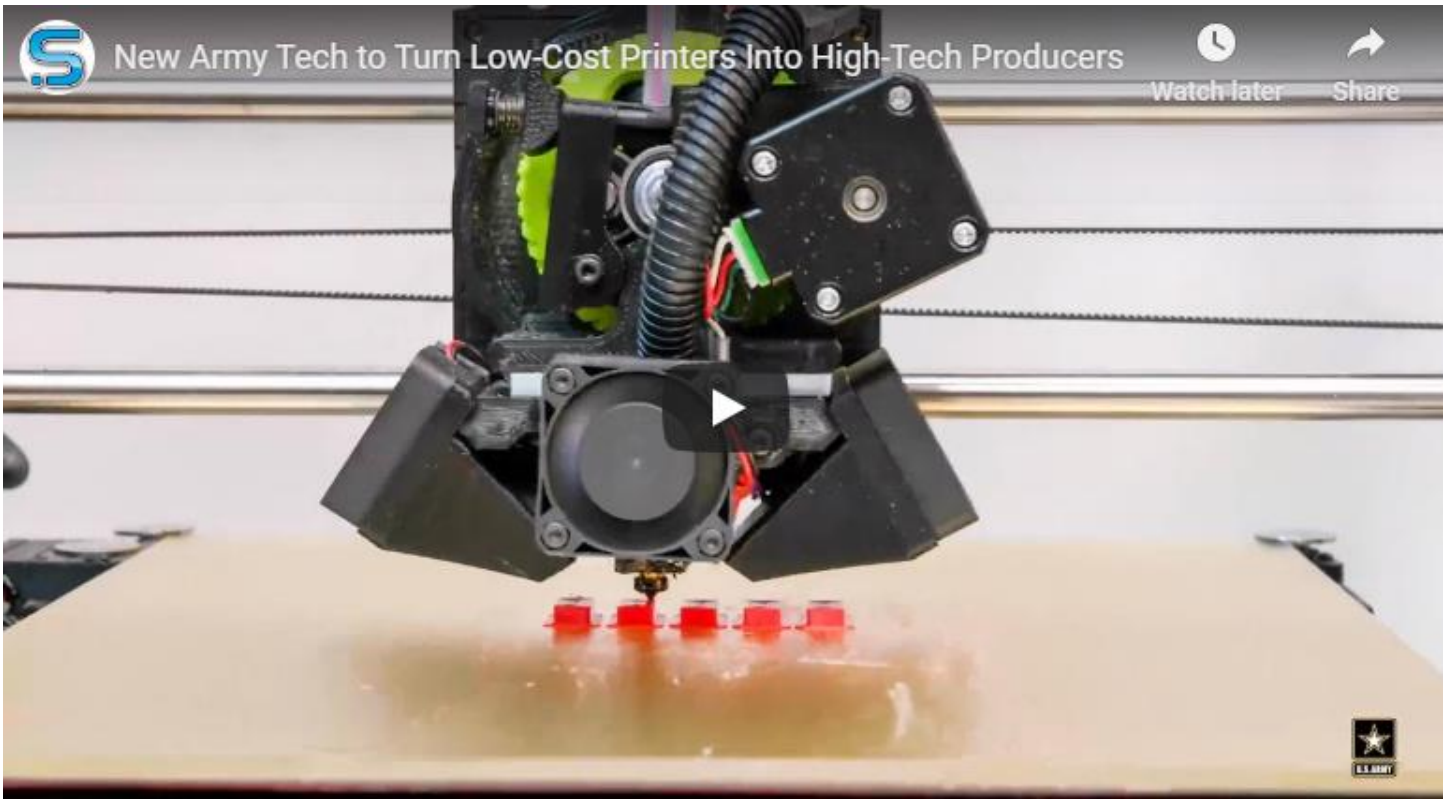
New Army Multi-Polymer Filament Tech Turns Low-Cost 3D Printers Into High-Tech Producers

Source: U.S. Army Research Laboratory

The Army has a new type of multi-polymer filament for commonly-used desktop 3-D printers. This advance may save money and facilitate fast printing of critical parts at the point of need.

The research is also the cover story of the April edition of Advanced Engineering Materials, a monthly peer-reviewed scientific journal.

Parts produced with these printers historically have had poor strength and toughness, which prevented affordable printers from being used to resupply military parts on demand, especially at deployed locations, until now. The Army's new material overcomes those deficiencies, potentially allowing Soldiers to use low-cost printers to create parts that, once subjected to a few hours of heat, can achieve mechanical properties robust enough to withstand the rigors of field operations.



This breakthrough is an important step forward for Army expeditionary manufacturing, said Dr. Eric D. Wetzel, who leads the Emerging Composites team and serves as the research area leader for Soldier Materials at the U.S. Army Combat Capabilities Development Command's **Army Research Laboratory**.

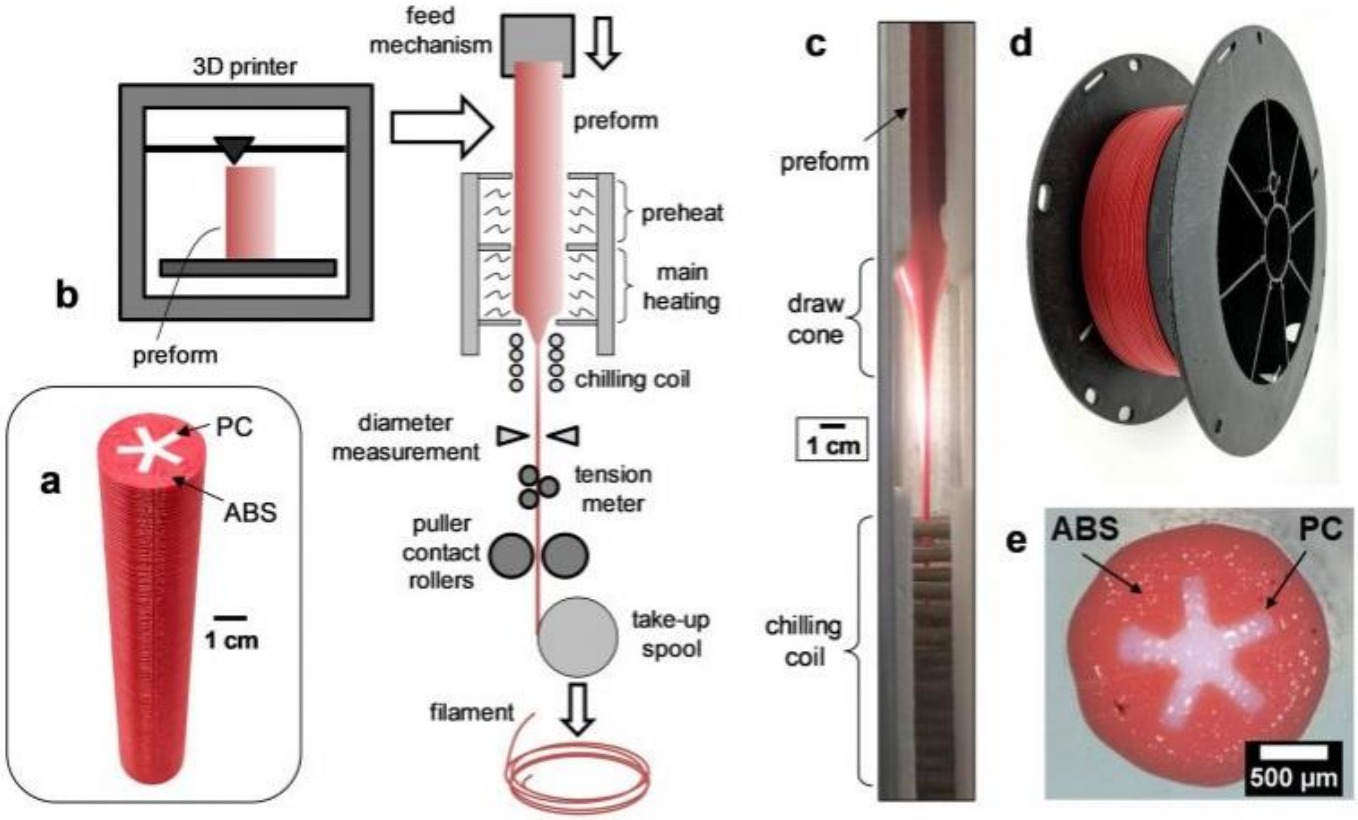
Wetzel's research encompasses a wide range of technological solutions that could increase Soldier lethality by enhancing the way warfighters shoot, move, communicate, protect and sustain themselves.

> "The Army would like to be able to print parts in the field to simplify logistics by carrying digital part files instead of physical parts, but to date, the technologies for producing high-strength parts have not been practical in an expeditionary setting. These printers are too large, energy-hungry, delicate or messy for starters, and their feedstocks can require specialized storage requirements."

This technology may enable the Army to use affordable, simple printers to produce high-quality parts.

According to the paper, fused filament fabrication or FFF, is the most common additive manufacturing technology, but parts fabricated using FFF lack sufficient mechanical integrity for most engineering applications.

The research team used a novel thermal draw process to fabricate a dual material filament comprising acrylonitrile butadiene styrene, known as ABS, with a star-shaped polycarbonate core.



The the thermal draw process for filament fabrication begins with the new multi-polymer filament invented by the CCDC Army Research Laboratory. Credit: U.S. Army

This dual material filament is then used as feedstock in a conventional FFF printer to create 3-D solid bodies with a composite ABS/polycarbonate core meso-structure.

This novel DM filament can revolutionize additive manufacturing allowing low-cost printers to produce parts with mechanical properties competitive with injection-molded plastics, as referenced in the paper.

In ongoing experiments, the Army's research team is experimenting with new material pairings, print conditions and annealing protocols to further improve mechanical properties and reduce processing times. Their goal is to reduce current annealing times of 24-48 hours to four hours or less.

Researchers are using a pilot manufacturing line to produce larger quantities of the filament over the next few months to provide material samples to a variety of Army transition partners.

"Having the option to additively manufacture parts from a high strength polymer via the FFF process, at the field, division, and/or depot level will certainly provide warfighters with the ability to produce better temporary parts much quicker – hours versus days or weeks – and at significantly lower costs – often pennies compared to tens of dollars, said Jeff Wallace, a mechanical engineer with the Army's C5ISR Center at APG. "Additionally, Soldiers tend to improvise as needed, often finding their own design solutions to the issues they face. As such, offering them a higher strength polymer material that can be used in the desktop printers they have access to, affords them the opportunity to innovate on-the-fly, as necessary to temporarily solve greater numbers of supply and design challenges. Their designs would then be sent to the proper Engineering Support Activity for evaluation."

The lab has filed multiple patent applications on the technology, and a license has already been granted for one aspect of the technology: thermally drawn filaments using a specialty polymer for use in additive manufacturing. The Army is looking for additional commercial partners to accelerate development and fielding of this technology, which could hold broad applicability to a wide range of additively manufactured thermoplastic parts.

Reference: "Tough, Additively Manufactured Structures Fabricated with Dual-Thermoplastic Filaments" by Kevin R. Hart, Ryan M. Dunn and Eric D. Wetzel, 10 December 2020, *Advanced Engineering Materials*.
DOI: 10.1002/adem.201901184

Talking Electric Car Battery Tech With Formula E Title Sponsor, ABB

Published by Forbes

With much of the automotive and motorsport world on hold due to Covid-19, I sat down (socially-distanced over the phone, of course) for a chat with Frank Muehlon, who is head of e-mobility infrastructure solutions for ABB, the German firm that is title sponsor of all-electric race series, Formula E.

ABB is a big name in electric vehicle charger infrastructure, making Muehlon a key industry figure when it comes to understanding the future of electric vehicles, and how their batteries will be charged.

Being associated with Formula E also gives ABB insight into how motorsport can offer a trickle-down effect, where technological learnings made on the race track filter down into road cars and their charging infrastructure.

Today's car chargers were beyond a dream in 2012
We began with the rate of innovation and improvements seen in electric vehicle charging, and just how quickly the benchmark has shifted in just eight years. "Things have accelerated for sure," Muehlon says. "When we started in 2012 I think no one was expecting 350kW [kilowatt] chargers and six of them at a 2mW [megawatt] charging site. I think this was far away from even dreaming."

Back then, just eight years ago, electric car chargers were generally offered with charge rates of 3.6 or 7.2 kilowatts. Some of these still remain as part of the public network, and the latter is still enough if charging a battery at home overnight. But rapid chargers, like those built in Europe by Ionity and in the US by Electrify America, are now up to the 350kW mark.

Muehlon adds with some astonishment: "If in 2012 you had shown someone a 350kW charger, I'm not sure what they would have called you."

For now, Porsche and its Taycan lead the charge, so to speak, with a charge rate of 270kW through a CCS charger. But this is only possible thanks to the car's innovative (and expensive) 800-volt architecture, double that of the 400v systems used by other electric cars.

Economies of scale
On such 800-volt systems coming to other vehicles Muehlon thinks it'll take some time. "Right now there are cost implications because of the economies of scale. The components are all available on the market for 400-volt, but not

so much for 800. So if you go for 800 you have to put more safety measures in place, and you tap into a supplier base with less economies of scale and that results in higher price tags.

"However, the advantages are pretty clear if you go for a higher voltage instead of current, you have a lot of savings in terms of weight and fewer efficiency losses. It makes a lot of sense, but for now it's more in the premium segment. But there are enough OEMs looking into it and I'm confident that a couple of years down the road we'll see more and more go to 800 volts."

Solid state battery technology is said to be the breakthrough electric cars need, with far faster charging times than what is available today. However, it's going to take a long time for the technology to arrive in the cars at your local dealership.

Muehlon explained: "I think it's pretty clear that the battery is really the biggest challenge of the EV sector and it will remain so… Solid state, yes, that's something everyone is talking about and we've seen prototypes. But we haven't seen mass-produced solid state batteries yet. There's a few guys out there saying give it another year, and others saying to give it another decade."

Formula One is a relic of the past

Being the title sponsor of Formula E, ABB is closely linked to motorsport. It also has a front row seat for watching how the focus from car manufacturers has shifted from Formula One and its hybrid power units, to the all-electric (albeit somewhat slower and arguably less glamorous) Formula E.

Muehlon says: "Looking at the green energy and the environmental push we see from society, Formula One becomes more and more outdated and more and more a relic of the past. In that sense, Formula E is pointing in the right direction… Initially people were laughing about it, asking can these cars really endure a whole race. But look at it now, we have better technology to survive a whole race, and we have all the car manufacturers in there which were before in F1."

When Formula E began in 2014, drivers had to change cars half-way through the 45 minute race due to their limited range, but since the second-generation car arrived in 2018, the 45-minute race can be completed in a single car. That essentially meant an impressive doubling of range in just four years. That said, F1 cars complete a 300km race in around 90 minutes without any refuelling.

Manufacturers taking part in Formula E for the 2020-2021 season (currently postponed due to the coronavirus) include Audi, BMW, Mercedes-Benz, Nio, Nissan, Jaguar and Porsche.

Will recharging come to Formula E races?

Given improvements in charging tech for electric cars, and how Formula E could be the ideal platform for ABB to show off its charging capabilities, I asked Muehlon if pitstops for battery top-ups could appear in future races.

"There are discussions about that, absolutely" he said, adding: "But we haven't finalized it yet because… you have to look at what you want to bring to a race. Do you want to bring excitement, or technology which you can also use in the real world?

"If you just do technology to create excitement, but never use it in reality, that's not what we want to do. If you find something that can close the gap and use Formula E as a proving ground, then yes."

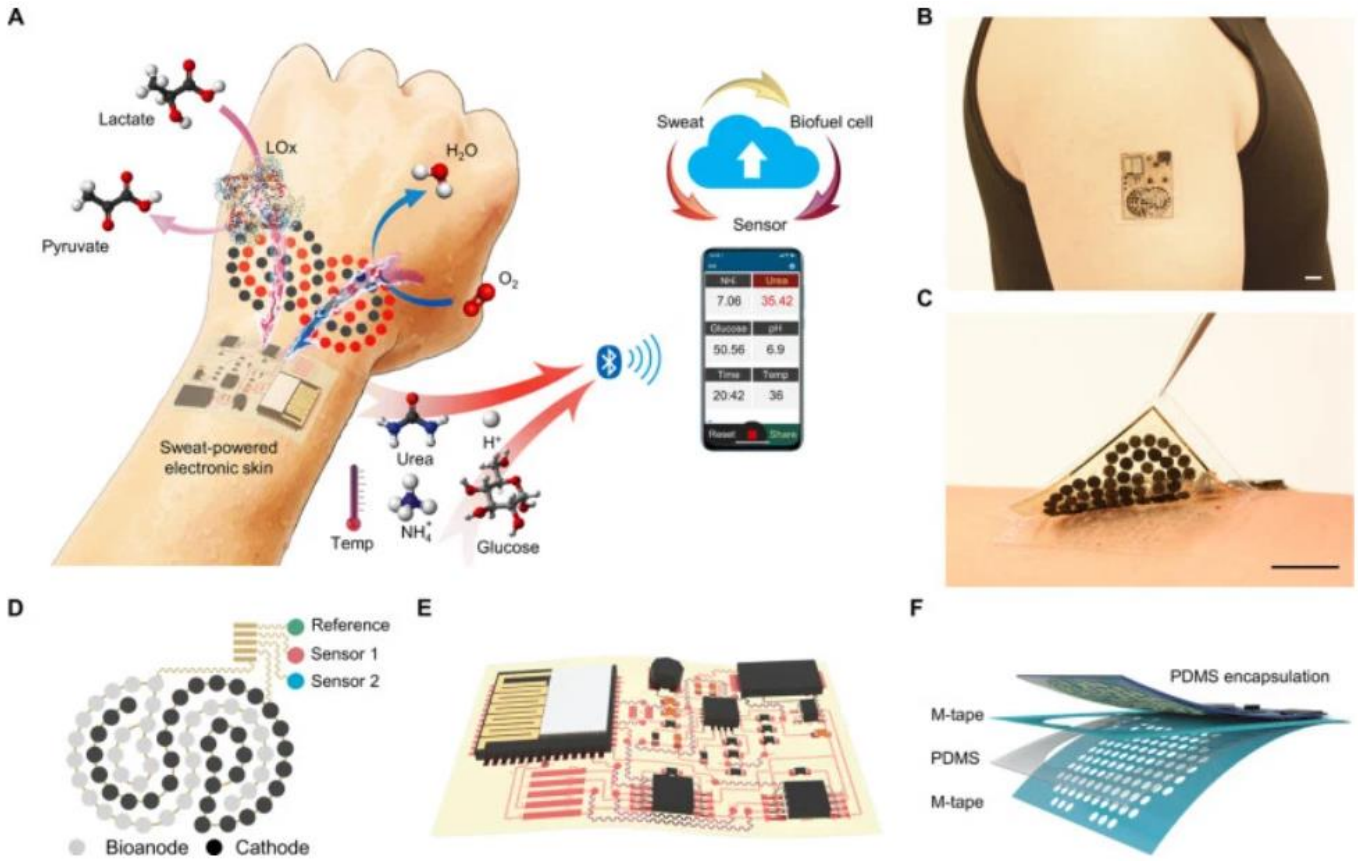
By Devin Coldewey

I see far more research articles than I could possibly write up. This column collects the most interesting of those papers and advances, along with notes on why they may prove important in the world of tech and startups.

This week: one step closer to self-powered on-skin electronics; people dressed as car seats; how to make a search engine for 3D data; and a trio of Earth imaging projects that take on three different types of disasters.

Sweat as biofuel

Monitoring vital signs is a crucial part of healthcare and is a big business across fitness, remote medicine and other industries. Unfortunately, powering devices that are low-profile and last a long time requires a bulky battery or frequent charging is a fundamental challenge. Wearables powered by body movement or other bio-derived sources are an area of much research, and this sweat-powered wireless patch is a major advance.



The device, described in Science Robotics, uses perspiration as both fuel and sampling material; sweat contains chemical signals that can indicate stress, medication uptake, and so on, as well as lactic acid, which can be used in power-generating reactions.

The patch performs this work on a flexible substrate and uses the generated power to transmit its data wirelessly. It's reliable enough that it was used to control a prosthesis, albeit in limited fashion. The market for devices like this will be enormous and this platform demonstrates a new and interesting direction for researchers to take.

'Ghostdrivers' behind the wheel test pedestrian reactions

Self-driving cars are sure to lead to major changes in traffic and pedestrian behaviors, but it's hard to tell exactly what those will be. Part of the challenge is that in most places in the world, there simply aren't any self-driving cars for people to react to — it may not even be legal to have them on the street.

It legitimately looks like a comedy sketch, but the results are quite interesting.

Hence researchers creating "Ghostdriven" cars, with real people at the wheel but disguised as empty car seats. Yes, it's strange, but if you think about it, it's rather like a blind for observing wildlife.

Driving the ostentatiously empty cars around areas where no self-driving cars are permitted or expected allowed the researchers to see a variety of responses among pedestrians. Some were wary, some bold, some scared, others curious.

"We discovered that there are many different localized rules and norms for how people interact with autonomous cars and with each other," said Cornell's Wendy Ju in a release describing the research. "This kind of research has to happen before autonomous systems are in place."

As she says, this type of study is necessary to inform both policy and AI behavior. A car in Mexico may need to signal its intentions differently from one in the Netherlands. And cars from different behavioral zones may need to know this about one another to keep their riders safe.

Searching 3D medical data

Tools for imaging the body have become quite sophisticated, and now produce quite enormous, high-resolution 3D models of things like healthy or diseased organs, neural pathways, and other important systems. But methods to handle, share and organize that data haven't advanced so quickly.

David Mayerich at the University of Houston is one of many around the world working on ways to index these enormous datasets.

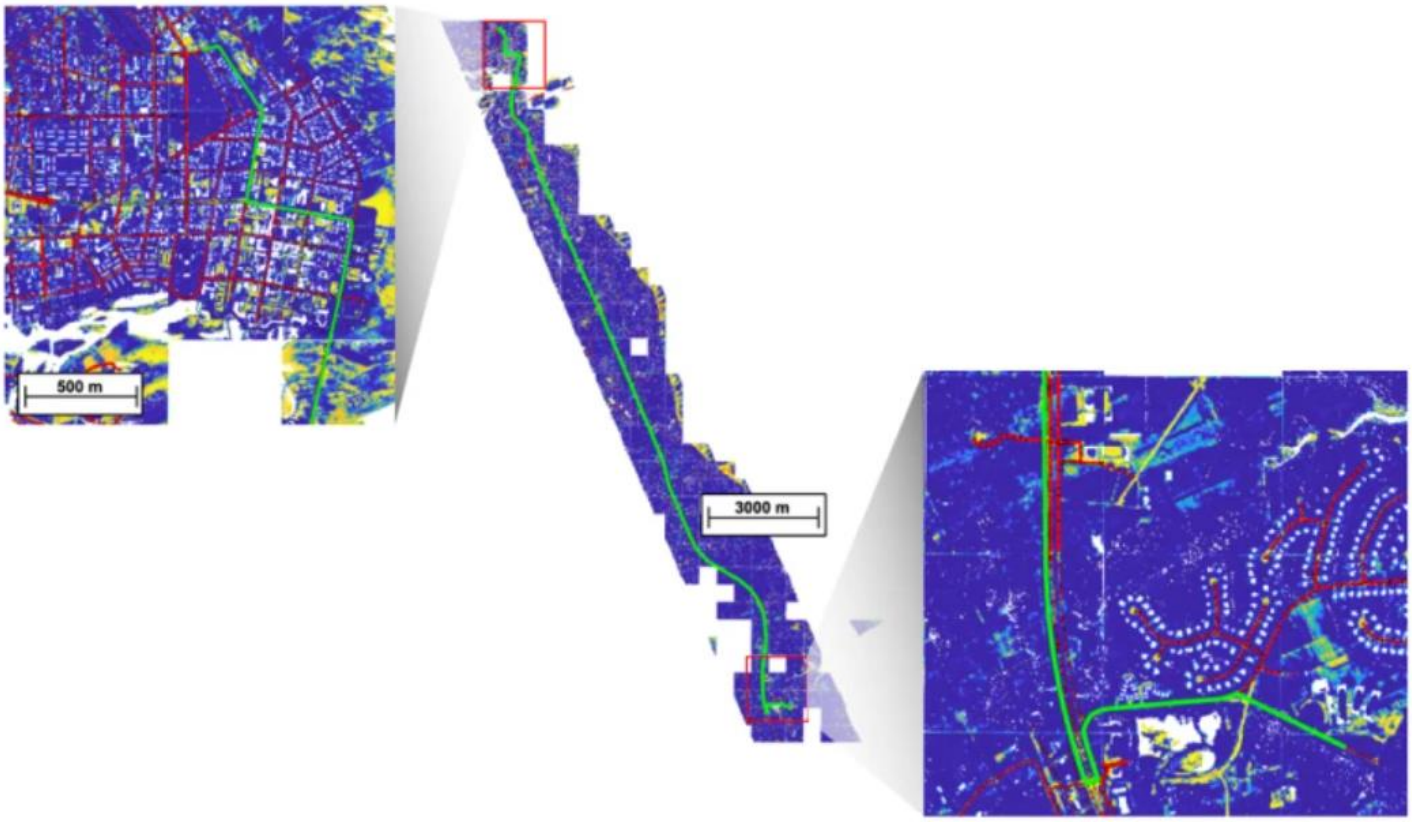
"We've developed this ability to collect massive amounts of data. Now we have to provide the software to make it accessible," he said in a UH news release. He's got a $500,000 grand from the National Science Foundation to develop a search engine for this kind of high-resolution 3D imagery.

Just as search engines ended up defining how we now use the web, the way we organize and surface medical data could define the next generation of telemedicine and treatment.

The view from above

A trio of Earth-imaging projects caught my eye this last week — there are constantly new applications of both satellite and aerial imagery, but these three seem especially relevant.

A trio of Earth-imaging projects caught my eye this last week — there are constantly new applications of both satellite and aerial imagery, but these three seem especially relevant.



First is an MIT project that's using lidar to map roads with more detail than ever before. Satellite data carefully sorted through by machine learning can make for very detailed maps, but finer details are needed when it comes to emergency services and maintenance.

Lidar imagery can poke through tree cover and find not just hidden roads but their condition (see top image). Knowing whether a surface is paved, dirt, rocky, muddy, occasionally flooded — and that data can be updated on short notice with the flight of a drone. That kind of information is extremely valuable during natural disasters and other emergencies.

Meanwhile, researchers from Plymouth Marine Laboratory are working on a method to track an ongoing man-made disaster: plastic littering in our oceans. There is lots of interest in tracking marine macroplastics (i.e. pieces larger than 5mm across), but it's a surprisingly difficult problem, unless you're looking for big patches of opaque waste.

The launch of **ESA's** Earth-imaging satellites Sentinel 2A and 2B might make things easier, though. The Plymouth team describes finding plastics using multispectral imagery and generating a library of spectral signatures — mixes of light frequencies — that indicate plastic mixed with kelp, plastic mixed with oil, with silt, etc.

That we can see plastic in the ocean from space has been shown several times over, but like any other science it needs to be constantly reevaluated and updated. Soon this type of data will be standard in the growing business of Earth-imaging indexes.

Lastly, Duke researchers are utilizing the huge increase in Earth imagery captured by Planet to better estimate and predict pollution. Concentrations of microparticles flucutate with weather and industry, but the best way to track them is via expensive ground stations — and you can't exactly build one of those every few miles.

The team instead used a library with more than 10,000 satellite images showing varying levels of pollution and fed that data to a machine learning system along with verified ground truth measurements. The system learned to pick

out tiny features in the images that correlate with different pollution levels and can now predict those levels to within 24% of the actual measurements (and that's actually pretty good).

More importantly, it can predict them for very small areas, say a city block versus a whole neighborhood. That makes it ripe for use in more local studies and perhaps even for inclusion in local weather reports.

"We think this is a huge innovation in satellite retrievals of air quality and will be the backbone of a lot of research to come," said Professor Mike Bergin, who led the team. "We're already starting to get inquiries into using it to look at how levels of PM2.5 are going to change once the world starts recovering from the spread of COVID-19."

By chemically forming multilayered, microscopic copper tubes on a sapphire substrate, then using capillary action to fill them with iron nanoparticles, a research team was able to fabricate high-impedance on-chip microinductors.

By Bill Schweber

Creating a basic indicator on a substrate sounds easy—just metallize the substrate, preferably with a spiral, serpentine, or other pattern. While traditional microchip inductors are relatively large 2D spirals of wire, a team at the University of Illinois Holonyak Micro and Nanotechnology Laboratory boosted the performance of its previously developed 3D inductor technology by up to three orders of magnitude using a more sophisticated technique.

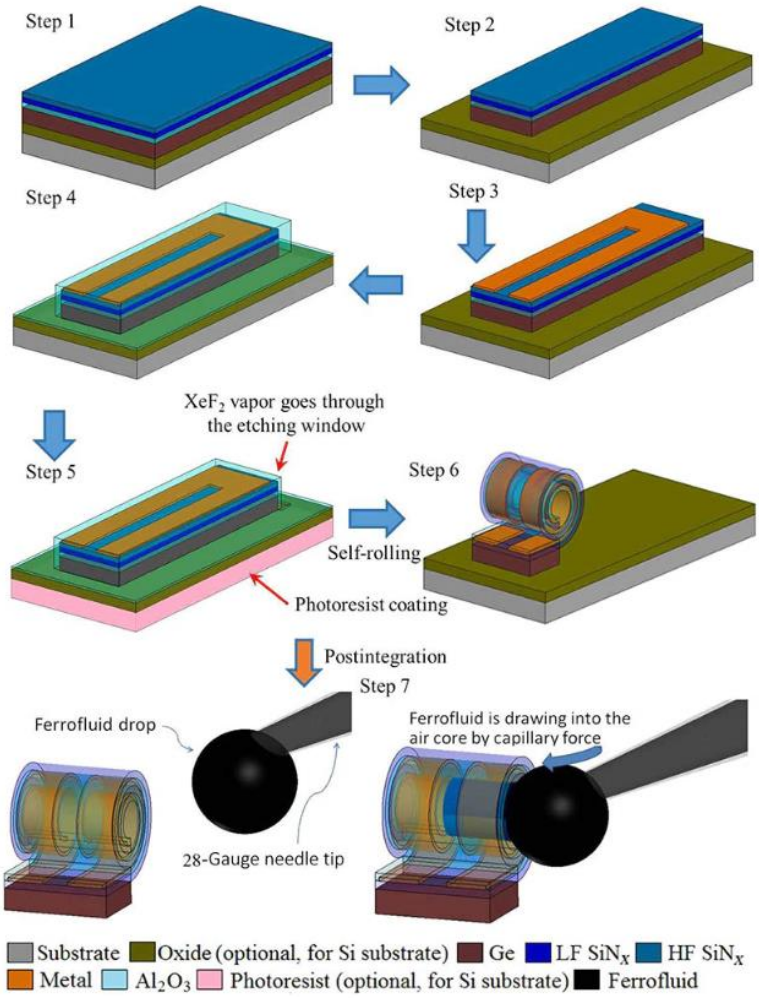
Their monolithic-on-sapphire non-MEMS approach uses a fully integrated, self-rolling, multilayered thin-wall copper tube filled with magnetic nanoparticles. The process, compatible with 2D semiconductor processing, created a condensed magnetic field distribution and energy-storage device in 3D space.

The team achieved inductance of 1.24 µH at 10 kHz for a single microtube inductor, with areal and volumetric inductance densities of 3 µH/mm2 and 23 µH/mm3, respectively. They also graphically characterized their Q (quality factor) and performance to 10 MHz. (In addition, they measured the magnetic strength of their inductors in microTesla, but those values are harder to relate to standard circuit-component parameters.)

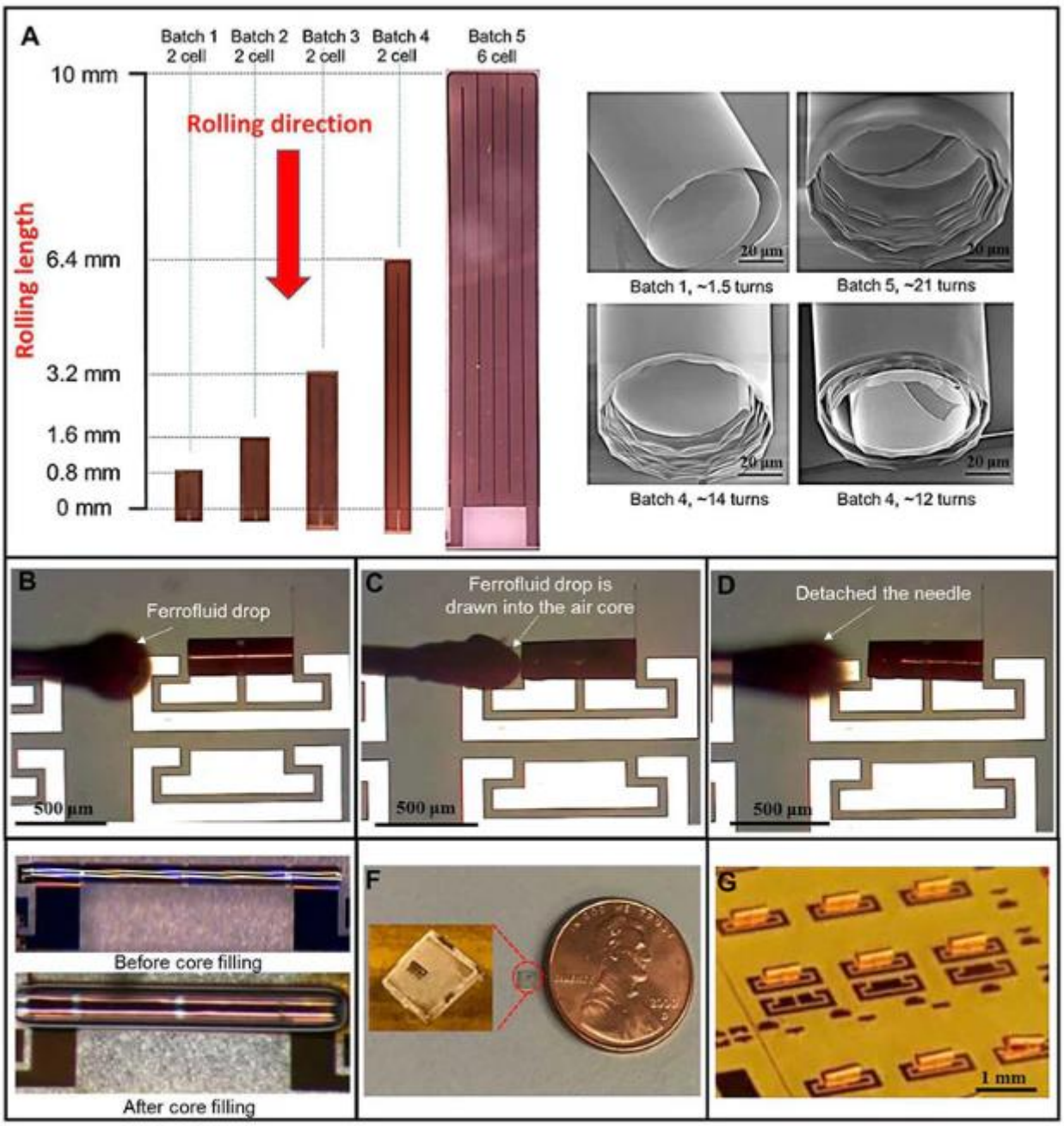
The first improvement was to work with the copper rolled tubes in the vapor phase. These tubes aren't merely simple, single-layered tubes like drinking straws, but instead are multi-turned cylindrical rolls. Project leader Prof. Xiuling Li noted that, "Previously, the self-rolling process was triggered and took place in a liquid solution. However, we found that while working with longer membranes, allowing the process to occur in a vapor phase gave us much better control to form tighter, more even rolls." The result is what they call a self-rolled-up membrane (S-RuM).

The second innovation was to create an iron core within the tubes. Li noted "The most efficient inductors are typically an iron core wrapped with metal wire, which works well in electronic circuits where size is not as important of a consideration. But that does not work at the microchip level, nor is it conducive to the self-rolling process, so we needed to find a different way." To do this, they filled the already-rolled membranes with an iron-oxide nanoparticle solution using a tiny dropper (Fig. 1).

Due to capillary pressure, the droplets of the solution are "sucked" into the tube cores. The



solution then dries while the iron nanoparticles remain inside the tubes, creating an analog to conventional solid-iron cores (Fig. 2).



2. Representative experimental demonstration of monolithic S-RuM power inductors: (A) The planar layout of six batches of successfully fabricated devices with the total rolling length (0.8 to 10 mm) and rolling direction, as well as the number of cells indicated. SEM images show the cross-sections of the fully rolled-up devices from batches 1, 4, and 5, with the number of turns indicated. (B to D) Ferromagnetic fluid drawn into a micropipette by capillary action with a droplet hanging at the tip (B); the pipette tip makes contact with the S-RuM air-core inductor tube (B), and capillary action forces the ferrofluid into the core of the inductor tube (C). Then, the pipette was withdrawn and detached from the core-filled S-RuM inductor tube (D). (E) Optical images of a six-cell 21-turn inductor before and after core filling. (F) A single two-cell inductor sitting on a piece of sapphire substrate placed by a U.S. penny for size comparison. (G) Optical image of an array of S-RuM inductor tubes fabricated monolithically. (Source: University of Illinois)

This isn't their first inductor effort. Previously, they developed 3D inductors using 2D processing by using a "rolled membrane" approach where wire spiraled out of plane and was separated by an insulating thin film from turn to turn. Those wire membranes, when unrolled, were 1 mm long but took up 100 times less space than the traditional 2D inductors. In contrast, these improved wire membranes have about 10X that length at 1 cm, yielding more turns and higher inductance in about the same amount of space.

Their lengthy paper "Monolithic mtesla-level magnetic induction by self-rolled-up membrane technology" (with 22 authors!) was published in Science Advances, along with equally detailed Supplementary Materials. There are also two short videos—one shows the rolling progress of a 1-cm-long microinductor and the other shows the ferrofluid-filling process for a short rolled microinductor:

- *The rolling progress of a 1cm – long microinductor*
- *The ferrofluid-filling process for a short rolled microinductor*

Also participating in this study, which was supported by The National Science Foundation Engineering Research Center for Power Optimization of Electro-Thermal Systems and the U.S. Department of Energy, were researchers from Stanford University, Hefei University of Technology, China, and the University of Twente, The Netherlands.

Case Study At-A-Glance: Coty Cosmetics

Coty Cosmetics is a worldwide cosmetics company behind such well-known brands as Sally Hansen, Rimmel and CoverGirl. At the company's factory in Maryland, eight Universal Robots on four mobile carts now automate the picking and packing of products at the powder presses.

The mobile solution delivers $500,000 in annual savings while improving both quality inspection and the employee work environment.

Challenge
For Paul Baublitz, project manager at Coty Cosmetics, the issue was clear: "We currently have twelve presses, and the challenge with automation is always how do you — in a cost-effective manner — automate such a large operation?"

Baublitz had multiple reasons for automating, including meeting the company's drive for increased efficiency as well as addressing the repetitive nature of the task, which was not ergonomically friendly for human operators. This was a task that Coty had previously looked into automating, but found that the technology available at the time wasn't up to the complexity of the application.

Baublitz brought the problem to Chris Sydorko, owner of the integration firm Sydorko Automation. "The challenge for me was to try to determine how I could build a robotic system that was mobile enough to meet their automation needs while still being cost-effective enough to meet their budgetary needs," said Sydorko.

Traditional industrial robots are not easily moved around due to safety regulations, which meant that Coty would have to permanently place a robot at each of the 12 presses. This was not within budget.

Solution
Instead, Sydorko looked to collaborative automation. "The Universal Robots seemed a great platform," he said. "They're lightweight, they're easy to use, they're low voltage, and certainly could work together in the same environment as individuals, so we decided to give the Universal Robots a shot."

The application involves picking up "godets" — metal pans containing powder cosmetics products — and placing them on trays packaged in boxes and sent to a different department for final processing. In the presses, powder is pushed into the godets, which then travel under a 3D profiler head from Cognex for surface inspection and to measure the volume of powder in the pan. If the godets pass inspection, a UR3 cobot picks them up in groups of two or four, depending on the product, and places them on a tray.

When the tray is full, a UR5 cobot picks the tray up and moves it to one of five case locations and places the tray in the case. The UR5 cobot then moves to where empty trays are stored, picks up a tray and places it back in the tray staging area, waiting for the next one to drop in front of the UR3 while it's loading.

The cobot-based carts currently run up to ten different product "recipes" for different godet shapes, which can range from round to square or rectangular, as well as various thicknesses and weights, and which can come out of the presses one or two at a time. The carts are designed for up to 20 product "recipes."

Set-up time and changeovers were key challenges to overcome in the application. With Universal Robots, Coty was able to mount a UR3 and UR5 cobot on each of four mobile carts that can be rolled from one press to another.

"It is much more cost-effective than having twelve different stations with robots at them," Baublitz said. "It made a project go from not being possible from a financial standpoint to being possible. Having them mobile was critical to making the project go forward."

Set-up time for the mobile cobots is typically just 15 to 30 minutes to unplug, move and set up the cobots at a new press.

Collaborative robots are designed for safe operation alongside human workers. But to meet required production rates, Coty needed to push the envelope of the robots' speed and force outside of the collaborative range. To protect operators, Sydorko added lightweight plexiglass guarding and light curtains. These don't inhibit the carts' mobility, but if a worker opens a door or reaches through an active area, the robots immediately drop into a safe collaborative speed. Once the worker shuts the door or moves out of the light curtain, the robots resume their maximum speed.

Results
For this collaborative automation project, Coty Cosmetics is projected to save $500,000 annually going forward. That's a significant return on investment, but Coty Cosmetics has seen other benefits as well.

The area where the robots work is dusty and noisy, with heavy vibration from the large presses. Now that the robots are working next to these sources, Coty is able to move employees farther away from this environment and redeploy them to less repetitive and more interesting tasks.

Baublitz explains, "Once this project is fully completed and running three shifts, five days a week, with four carts, there are going to be thirteen fewer employees working in that area. That's a significant change for the organization, with a lot of efficiency improvements, and the team's very excited about that."

Baublitz also points to new quality initiatives that the Cognex inspection system adds to the automated work cells. Previously, this was one of many tasks that operators performed. "Now there's a computer doing all of that work," Baublitz explains. "If you see something that needs to be improved, you can immediately react."

Now that the cobot-based system is set up, however, the Coty team is able to manage it internally. “If there’s ever any troubleshooting that’s needed, the integrator that we worked with is always a phone call away,” says Baublitz. “But at this point, we’ve been running with the carts for months and we’re comfortable enough that we can troubleshoot 99 percent of the issues in-house.”

With 6GHz boost, expect Wi-Fi 6 to encroach on 5G's aspirations

By Mike Dano

The Wi-Fi industry recently received a major boost from the FCC, which voted to release an enormous amount of new spectrum in the 6GHz band for unlicensed operations. The action – coupled with the recent release of the new Wi-Fi 6 technology standard – could position Wi-Fi to carve out some of the revenue opportunities currently targeted by the 5G industry.

Specifically, executives in the Wi-Fi industry have named roaming, fixed wireless, telehealth, VR, precision manufacturing, private networks and smart cities as areas for expansion – all areas that have also been bandied about as 5G opportunities.

But, to be clear, the lines in this discussion are decidedly blurry.

"It's tempting to think of cellular connectivity and particularly 5G as a rival to Wi-Fi. But it's not so simple in reality, as the two are being designed to complement each other," writes CCS Insight analyst Geoff Blaber.

And it's certainly true that each of these growth areas has its own unique characteristics. For example, there's little doubt that most VR applications will use Wi-Fi indoors but will need a 5G connection to work around town. Similarly, Wi-Fi has long been used by enterprises of all shapes and sizes for private wireless networking – and there's no reason to expect that to change – but Wi-Fi simply can't cover the kinds of enormous geographic areas that some 4G and 5G proponents are eyeing.

Further, some companies stand to benefit from both technologies, albeit in their own ways. Cisco, for example, sells both Wi-Fi access points and 5G core network software. Similarly, Intel sells chips for 5G basestations alongside chips for laptops that are virtually useless without Wi-Fi.

But there are plenty of other companies – replete with thousands of employees – that have a very vested interest in the debate over Wi-Fi and 5G. Qualcomm, for example, has been very vocal in its support for the FCC's 6GHz ruling, but a huge chunk of the company's business is tied up in 5G. And Nokia and Ericsson won't sell much 5G equipment for a telehealth service that uses Wi-Fi.

That's why there's a quiet but heated battle between the two technologies going on in a handful of select verticals. In fixed wireless, for instance, providers may decide to opt for cheaper Wi-Fi equipment in the 6GHz band rather than ponying up for official 5G equipment from the likes of Ericsson or Nokia. Already there are examples of fixed wireless providers – Starry and Common Networks, for example – that have selected 802.11-based kit for just that reason.

Similarly, giant manufacturing conglomerates may decide to simply upgrade the existing Wi-Fi networks in their factories to the new and more capable Wi-Fi 6 technology standard rather than deploying a whole new 5G network. Although some manufacturing firms like ABB are testing 5G, others like Mettis Aerospace have already opted for Wi-Fi 6.

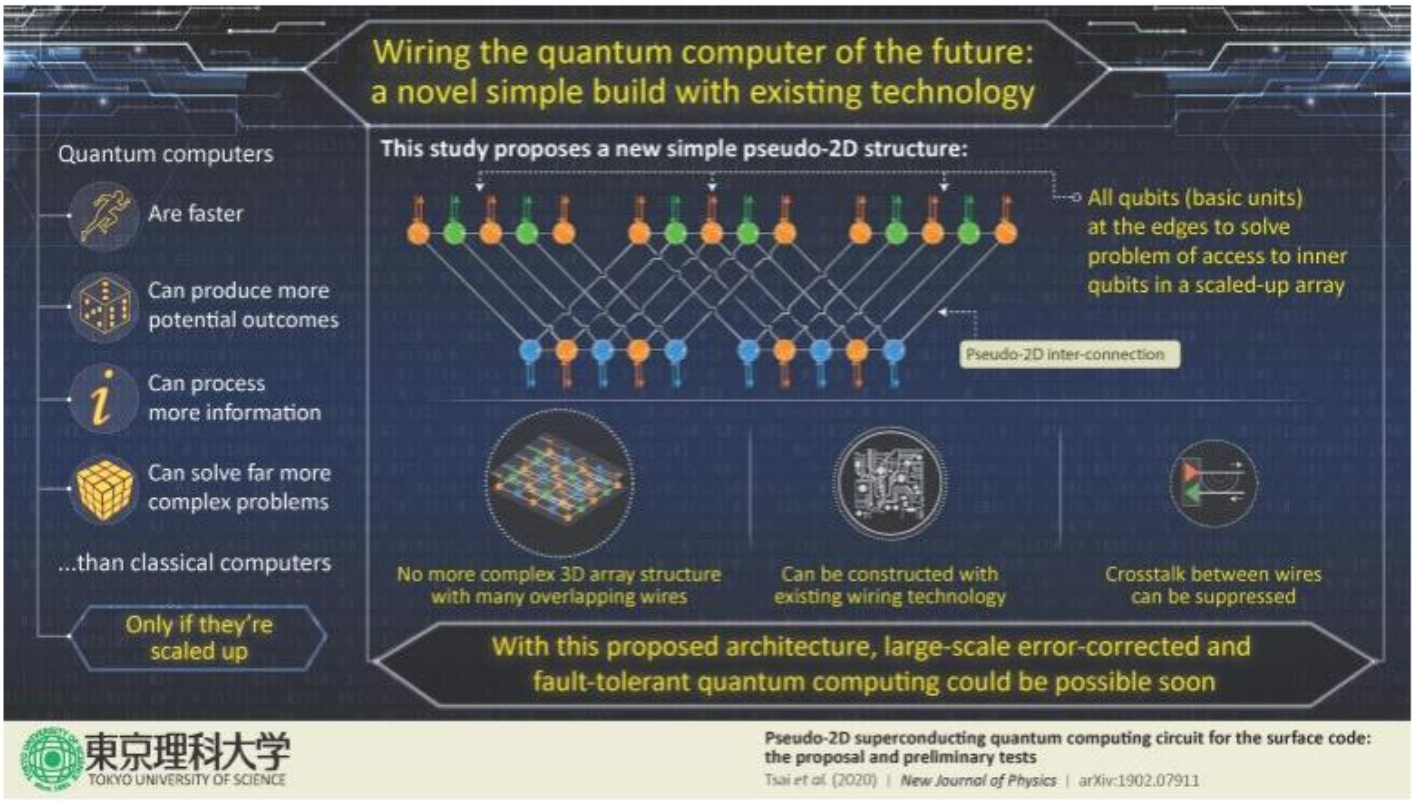
And building owners may decide to forego a fancy new 5G network for indoor coverage, thanks to the Wi-Fi OpenRoaming standard. That specification, developed by Cisco but now handled by the Wireless Broadband Alliance, seamlessly connects Wi-Fi devices to pre-approved networks – just like 3G and 4G cellular networks do when customers are roaming. The companies that are designing, building, selling and installing indoor 5G equipment may not be happy about this kind of development.

Indeed, the Wi-Fi advocacy organization WifiForward recently commissioned a study that found cellular operators could save up to $13.6 billion between 2020 and 2025 by offloading their 5G traffic onto Wi-Fi networks. Meaning, they won't spend that money with 5G equipment suppliers.

No wonder Ericsson proposed last year that the FCC set aside the upper portion of the 6GHz band for licensed uses, such as 5G.

All that said, the story isn't over yet. Via the 3GPP standards group, the 5G industry is putting the final touches on a version of the technology specifically tailored for operations in unlicensed spectrum – unlicensed spectrum like 6GHz.

Source Tokyo University Of Science



Constructing a small-scale circuit to further examine and explore the possibility. Credit: Tokyo University of Science

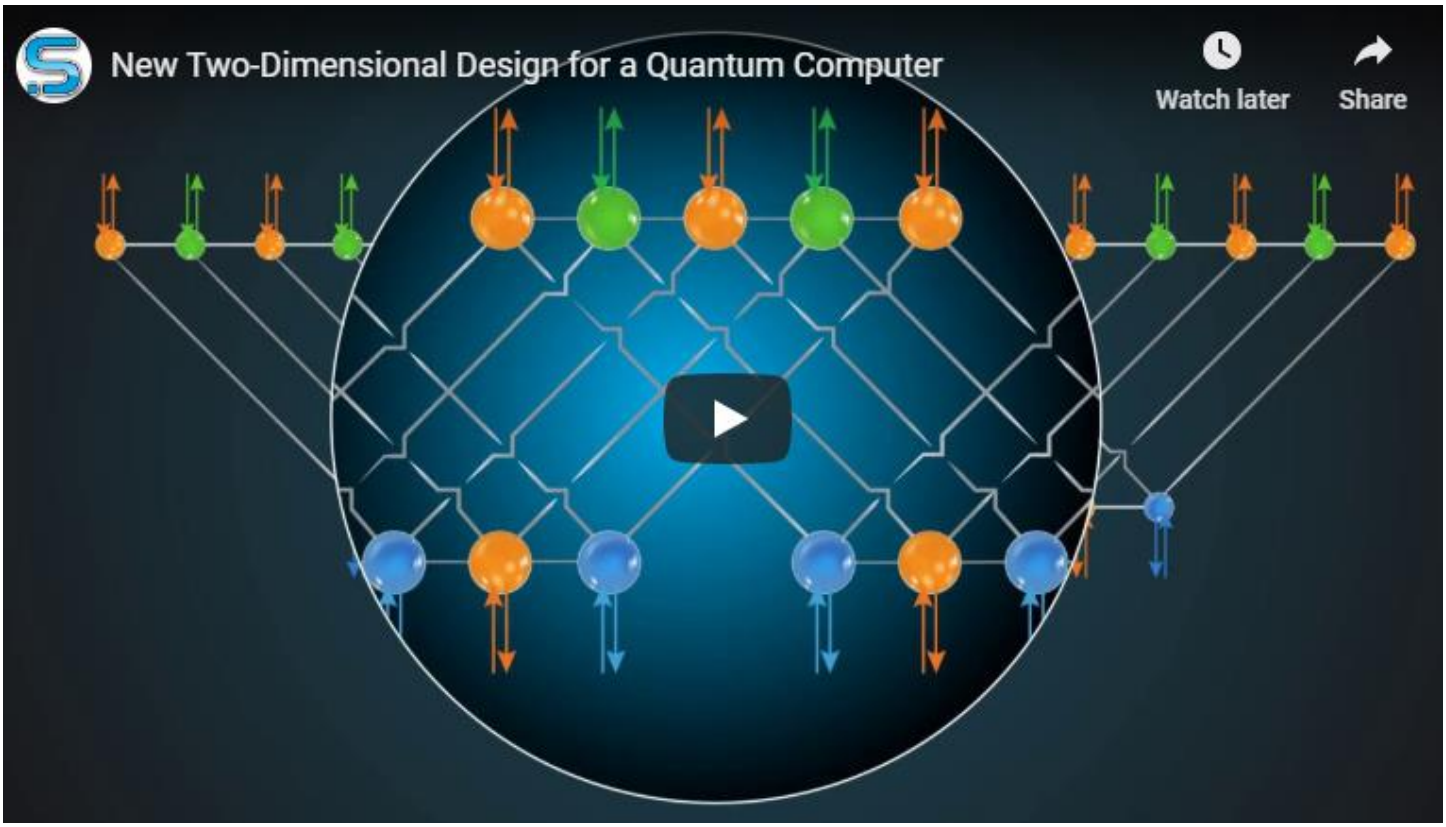
The basic units of a quantum computer can be rearranged in 2D to solve typical design and operation challenges.

Quantum computing is increasingly becoming the focus of scientists in fields such as physics and chemistry, and industrialists in the pharmaceutical, airplane, and automobile industries. Globally, research labs at companies like Google and IBM are spending extensive resources on improving quantum computers, and with good reason. Quantum computers use the fundamentals of quantum mechanics to process significantly greater amounts of information much faster than classical computers. It is expected that when error-corrected and fault-tolerant quantum computation is achieved, scientific and technological advancement will occur at an unprecedented scale.

But, building quantum computers for large-scale computation is proving to be a challenge in terms of their architecture. The basic units of a quantum computer are the "quantum bits" or "qubits." These are typically atoms, ions, photons, subatomic particles such as electrons, or even larger elements that simultaneously exist in multiple states, making it possible to obtain several potential outcomes rapidly for large volumes of data. The theoretical requirement for quantum computers is that these are arranged in two-dimensional (2D) arrays, where each qubit is both coupled with its nearest neighbor and connected to the necessary external control lines and devices. When the number of qubits in an array is increased, it becomes difficult to reach qubits in the interior of the array from the edge. The need to solve this problem has so far resulted in complex three-dimensional (3D) wiring systems across multiple planes in which many wires intersect, making their construction a significant engineering challenge.

A group of scientists from Tokyo University of Science, Japan, RIKEN Centre for Emergent Matter Science, Japan, and University of Technology, Sydney, led by Prof Jaw-Shen Tsai, proposes a unique solution to this qubit

accessibility problem by modifying the architecture of the qubit array. "Here, we solve this problem and present a modified superconducting micro-architecture that does not require any 3D external line technology and reverts to a completely planar design," they say. **This study** has been published in the *New Journal of Physics*.



The scientists began with a qubit square lattice array and stretched out each column in the 2D plane. They then folded each successive column on top of each other, forming a dual one-dimensional array called a "bi-linear" array. This put all qubits on the edge and simplified the arrangement of the required wiring system. The system is also completely in 2D. In this new architecture, some of the inter-qubit wiring–each qubit is also connected to all adjacent qubits in an array–does overlap, but because these are the only overlaps in the wiring, simple local 3D systems such as airbridges at the point of overlap are enough and the system overall remains in 2D. As you can imagine, this simplifies its construction considerably.

The scientists evaluated the feasibility of this new arrangement through numerical and experimental evaluation in which they tested how much of a signal was retained before and after it passed through an airbridge. Results of both evaluations showed that it is possible to build and run this system using existing technology and without any 3D arrangement.

The scientists' experiments also showed them that their architecture solves several problems that plague the 3D structures: they are difficult to construct, there is crosstalk or signal interference between waves transmitted across two wires, and the fragile quantum states of the qubits can degrade. The novel pseudo-2D design reduces the number of times wires cross each other, thereby reducing the crosstalk and consequently increasing the efficiency of the system.

At a time when large labs worldwide are attempting to find ways to build large-scale fault-tolerant quantum computers, the findings of this exciting new study indicate that such computers can be built using existing 2D integrated circuit technology. "The quantum computer is an information device expected to far exceed the capabilities of modern computers," Prof Tsai states. The research journey in this direction has only begun with this

study, and Prof Tsai concludes by saying, "We are planning to construct a small-scale circuit to further examine and explore the possibility."

Reference: "Pseudo-2D superconducting quantum computing circuit for the surface code: proposal and preliminary tests" by Hiroto Mukai, Keiichi Sakata, Simon J Devitt, Rui Wang, Yu Zhou, Yukito Nakajima and Jaw-Shen Tsai, 21 April 2020, *New Journal of Physics*.

DOI: 10.1088/1367-2630/ab7d7d

Tokyo University of Science (TUS) is a well-known and respected university, and the largest science-specialized private research university in Japan, with four campuses in central Tokyo and its suburbs and in Hokkaido. Established in 1881, the university has continually contributed to Japan's development in science through inculcating the love for science in researchers, technicians, and educators.

With a mission of "Creating science and technology for the harmonious development of nature, human beings, and society", TUS has undertaken a wide range of research from basic to applied science. TUS has embraced a multidisciplinary approach to research and undertaken intensive study in some of today's most vital fields. TUS is a meritocracy where the best in science is recognized and nurtured. It is the only private university in Japan that has produced a Nobel Prize winner and the only private university in Asia to produce Nobel Prize winners within the natural sciences field.

Chenming Hu, the 2020 IEEE Medal of Honor recipient, took transistors into the third dimension

By Tekla S. Perry

It was 1995. Advances in chip technology continued apace with Moore's Law, the observation that the number of transistors on a chip doubles roughly every two years, generally because of the shrinking size of those transistors.

But the horizon no longer seemed limitless. Indeed, for the first time, murmurs throughout the semiconductor industry predicted the death of Moore's Law. The golden days would be coming to an end, the predictions went, when the size of a critical transistor feature, then around 350 nanometers, reached below 100 nm. Even the U.S. government was worried—so worried that DARPA raised an alarm, launching a program seeking new chip technologies that could extend progress.

Chenming Hu, then a professor of electrical engineering and computer science at the University of California, Berkeley, jumped at the challenge. He immediately thought of a solution—actually, two solutions—and, on a plane ride a few days later, sketched out those designs. One of those ideas, raising the channel through which current flows so that it sticks out above the surface of the chip, became the FinFET, a technology that earned Hu this year's IEEE Medal of Honor "for a distinguished career of developing and putting into practice semiconductor models, particularly 3-D device structures, that have helped keep Moore's Law going over many decades."

The story of the FinFET didn't begin with Hu putting pencil to paper on an airline tray table, of course.

It started in Taiwan, where Hu was a curious child, conducting stove-top experiments on seawater and dismantling—and reassembling—alarm clocks. As he approached the end of high school, he was still interested in science, mostly chemistry. But instead of targeting a chemistry degree, he applied for the electrical engineering program at the National Taiwan University, even though he didn't really know what an EE actually did. It was simply a challenge—the electrical engineering program required the highest test scores to get in.

During his last year of college, Hu discovered the industry he would later shake up, thanks to Frank Fang, then a visiting professor from the United States.

"It was 1968," Hu recalls, "and he told us semiconductors were going to be the material for future televisions, and the televisions would be like photographs we could hang on the wall."

That, in an era of bulky tube televisions, got Hu's attention. He decided that semiconductors would be the field for him and applied to graduate programs in the United States. In 1969, he landed at Berkeley, where he joined a research group working on metal-oxide semiconductor (MOS) transistors.

His career soon took a detour because semiconductors, he recalls, just seemed too easy. He switched to researching optical circuits, did his Ph.D. thesis on integrated optics, and went off to MIT to continue his work in that field.

But then came the 1973 oil embargo. "I felt I had to do something," he said, "something that was useful, important; that wasn't just writing papers."

So he switched his efforts toward developing low-cost solar cells for terrestrial applications—at the time, solar cells were used only on satellites. In 1976, he returned to Berkeley, this time as a professor, planning to do research in

energy topics, including hybrid cars, an area that transported him back to semiconductors. "Electric cars," Hu explains, "needed high voltage, high current semiconductor devices."

Come the early 1980s, that move back to semiconductor research turned out to be a good thing. Government funding for energy research dried up, but a host of San Francisco Bay Area companies were supporting semiconductor research, and transitioning to corporate funding "was not very difficult," Hu says. He started spending time down in Silicon Valley, not far from Berkeley, invited by companies to teach short courses on semiconductor devices. And in 1982, he spent a sabbatical in the heart of Silicon Valley, at National Semiconductor in Santa Clara.

"Being in industry then ended up having a long influence on me," Hu says. "In academia, we learn from each other about what is important, so what I thought was interesting really came just because I was reading another paper and felt, 'Hey, I can do better than that.' But once I opened my eyes to industry, I found that's where the interesting problems are." And that epiphany got Hu looking harder at the 3D structure of transistors.

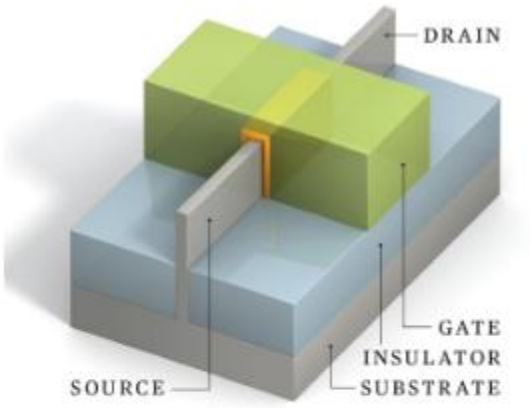


Illustration: Emily Cooper

FinFET's Features: Every transistor has a source, a drain, a conductive channel that connects them, and a gate to control the flow of current down the channel. In a FinFET, raising the channel so that it sticks up above the surface of the chip—like a shark's fin—allows the gate to wrap around it on three sides, giving the gate greater control.

A field-effect transistor has four basic parts—a source, a drain, a conductive channel that connects the two, and a gate to control the flow of current down the channel. As these components were made smaller, people started noticing that the behaviors of transistors were changing with long-term use. These changes weren't showing up in short-term testing, and companies had difficulty predicting the changes.

In 1983, Hu read a paper published by researchers at IBM that described this challenge. Having spent time at National Semiconductor, he realized the kinds of problems this lack of long-term reliability could cause for the industry. Had he not worked in the trenches, he says, "I wouldn't have known just how important a problem it was, and so I wouldn't have been willing to spend nearly 10 years working on it."

Hu decided to take on the challenge, and with a group of students he developed what he called the hot-carrier-injection theory for predicting the reliability of MOS semiconductors. It's a quantitative model for how a device degrades as electrons migrate through it. He then turned to investigating another reliability problem: the ways in which oxides break down over time, a rising concern as manufacturers made the oxide layers of semiconductors thinner and thinner.

These research efforts, Hu says, required him to develop a deep understanding of what happens inside transistors, work that evolved into what came to be called the Berkeley Reliability Tool (BERT) and BSIM, a set of transistor models. BSIM became an industry standard and remains in use today; Hu still leads the effort to regularly update its models.

Hu continued to work with his students to study the basic characteristics of transistors—how they work, how they fail, and how they change over time—well into the 1990s. Meanwhile, commercial chips continued to evolve along the path predicted by Moore's Law. But by the mid-1990s, with the average feature size around 350 nm, the prospects for being able to shrink transistors further had started looking worrisome.

"The end of Moore's Law was in view," recalls Lewis Terman, who was at IBM Research at the time.

The main problem was power. As features grew smaller, current that leaked through when a transistor was in its "off" state became a bigger issue. This leakage is so great that it increased—or even dominated—a chip's power consumption.

"Papers started projecting that Moore's Law for CMOS would come to an end below 100 nm, because at some point you would dissipate more watts per square centimeter than a rocket nozzle," Hu recalled. "And the industry declared it a losing battle."

Not ready to give up on Moore's Law, DARPA (the Defense Advanced Research Projects Agency) looked to fund research that promised to break that barrier, launching an effort in mid-1995 to develop what it called the 25-nm Switch.

"I liked the idea of 25 nm—that it was far enough beyond what the industry thought possible," Hu says.

Hu saw the fundamental problem as quite clear—making the channel very thin to prevent electrons from sneaking past the gate. To date, solutions had involved thinning the gate's oxide layer. That gave the gate better control over the channel, reducing leakage current. But Hu's work in reliability had shown him that this approach was close to a limit: Make the oxide layer sufficiently thin and electrons could jump across it into the silicon substrate, forming yet another source of leakage.

Two other approaches immediately came to mind. One involved making it harder for the charges to sneak around the gate by adding a layer of insulation buried in the silicon beneath the transistor. That design came to be called fully depleted silicon-on-insulator, or FDSOI. The other involved giving the gate greater control over the flow of the charge by extending the thin channel vertically above the substrate, like a shark's fin, so that the gate could wrap around the channel on three sides instead of just sitting on top. This structure was dubbed the FinFET, which had the additional advantage that using space vertically relieved some of the congestion on the 2D plane, ushering in the era of 3D transistors.

There wasn't a lot of time to get a proposal submitted to DARPA, however. Hu had heard about the DARPA funding from a fellow Berkeley faculty member, Jeffrey Bokor, who, in turn, had heard about it while windsurfing with a DARPA program director. So Hu quickly met with Bokor and another colleague, Tsu Jae King, and confirmed that the team would pull together a proposal within a week. On a plane trip to Japan a day or two later, he sketched out the two designs, faxing his sketches and a description of his technical approach back to Berkeley when he arrived at his hotel in Japan. The team submitted the proposal, and DARPA later awarded them a four-year research grant.

Ideas similar to FinFET had been described before in theoretical papers. Hu and his team, however, actually built manufacturable devices and showed how the design would make transistors 25 nm and smaller

Chenming Hu

Photo: Peter Adams

Date of birth: 12 July 1947

Birthplace: Beijing

Height: 5'11"

Family: Wife, Margaret; sons, Raymond and Jason

Education: BS, National Taiwan University, 1968; MS, 1970 and Ph.D., 1973, University of California, Berkeley, all in electrical engineering

First job: Tutor for high school students

First technology job: Assistant professor, MIT

Current job: TSMC Distinguished Professor Emeritus, University of California, Berkeley

Patents: More than 100

Biggest surprise in career: Just how far semiconductor technology has come

Corporate board memberships: ACM Research, Ambarella, Inphi

Hero: Morris Chang

Favorite periodical: *Psychology Today*

Favorite kind of music: Classical

Favorite movie: *Jurassic Park*(1993)

Leisure activities: Painting, hiking

Languages spoken: English and Mandarin

Car: Tesla S

Philanthropic Focus: Friends of Children With Special Needs, Fremont, Calif.; Asian Health Services, Oakland, Calif.

Organizational memberships: IEEE, National Academy of Engineering, Chinese Academy of Sciences

Major awards: IEEE Medal of Honor "for a distinguished career of developing and putting into practice semiconductor models, particularly 3-D device structures, that have helped keep Moore's Law going over many decades," National Medal of Technology and Innovation from President Barack Obama

possible. “The others who read the papers didn’t see it as a solution, because it would be hard to build and may or may not work. Even the people who wrote the papers did not pursue it,” says Hu. “I think the difference was that we looked at it and said, we want to do this not because we want to write another paper, or get another grant, but because we want to help the industry. We felt we had to keep [Moore’s Law] going.

“As technologists,” Hu continues, “we have the responsibility to make sure the thing doesn’t stop, because once it stops, we’re losing the biggest hope for us to have more abilities to solve the world’s difficult problems.”

Hu and his team “were well-poised to develop the FinFET because of the way he trains his students to think about devices,” says Elyse Rosenbaum, a former student of his and now a professor at the University of Illinois at Urbana-Champaign. “He emphasizes big picture, qualitative understanding. When studying a semiconductor device, some people focus on creating a model and then numerically solving all the points in its 3D grid. He taught us to step back, to try to visualize where the electric field is distributed in a device, where the potential barriers are located, and how the current flow changes when we change the dimension of a particular feature.”

Hu felt that visualizing the behavior of semiconductor devices was so important, Rosenbaum recalls, that once, struggling to teach his students his process, he “built us a model of the behavior of an MOS transistor using his kids’ Play-Doh.”

“These things looked like a lightning invention,” said Fari Assaderaghi, a former student who is now senior vice president of innovation and advanced technology at NXP Semiconductors. “But his team had been working on fundamental concepts of what an ideal device should be, working from first principles of physics early on; how to build the structure comes from that.”

By 2000, at the end of the four-year grant term, Hu and his team had built working devices and published their research, raising immediate, widespread interest within the industry. It took another decade, however, before chips using FinFETs began rolling off of manufacturing lines, the first from Intel in 2011. Why so long?

“It was not broken yet,” Hu explains, referring to the industry’s ability to make semiconductor circuits more and more compact. “People were thinking it was going to break, but you never fix anything that’s not broken.”

It turned out that the DARPA program managers were prescient—they had called the project the 25-nm Switch, and FinFETs came into play when the semiconductor industry moved to sub-25-nm geometries.

FDSOI, meanwhile, also progressed and is also being used in industry today. In particular, it’s found in optical and RF devices, but FinFETs currently dominate the processor industry. Hu says he never really promoted one approach over the other.

In FinFET’s dormant years, Hu took a three-year break from Berkeley to serve as chief technology officer of semiconductor manufacturer TSMC in Taiwan. He saw that as a chance to pay back the country where he received his initial education. He returned to Berkeley in 2004, continuing his teaching, research in new energy-efficient semiconductor devices, and efforts to support BSIM. In 2009, Hu stopped teaching regular classes, but as a professor emeritus, he still works with graduate students. Since Hu moved back to Berkeley, FinFET technology has swept the industry. And Moore’s Law did not come to an end at 25 nm, although its demise is still regularly predicted.

“It is going to gradually slow down, but we aren’t going to have a replacement for MOS semiconductors for a hundred years,” Hu says. This does not make him pessimistic, though. “There are still ways of improving circuit density and power consumption and speed, and we can expect the semiconductor industry to keep giving people more and more useful and convenient and portable devices. We just need more creativity and a big dose of confidence.”

A DIY experiment at IBM Research–Europe became a valuable tool

By Yuksel Temiz

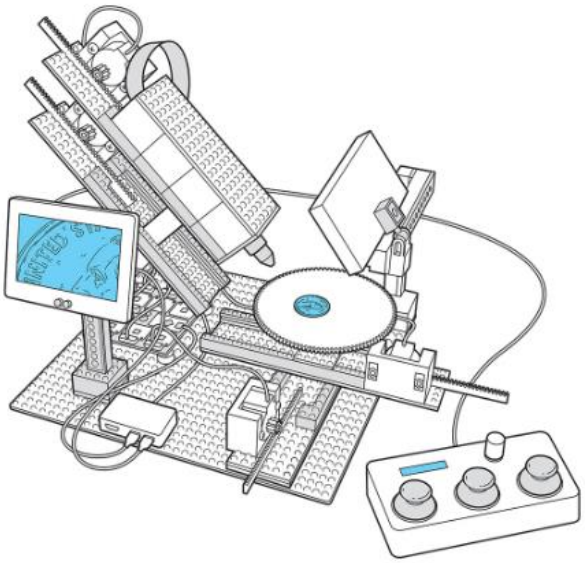


Illustration: James Provost

I am a member of a team at IBM Research–Europe, in Zurich, developing microfluidic technologies for medical applications. Two years ago, I was asked to provide high-quality photos and videos of our microfluidic chips for a big tech event. I borrowed a 4K camcorder from a colleague, attached a macro lens to it, built a custom light diffuser using an LED matrix and polyester film, and positioned everything using a high-end tripod and a few micromanipulators. I was able to take eye-catching videos as liquids filled microfluidic channels. It was clear to me that this should be the new level of quality and style for our publications and presentations. However, my photo setup occupied half a bench in our lab and it required hours of fine adjustments to record one shot.

We have a tradition of inventing microscopes at IBM in Zurich. In 1981, Gerd Binnig and Heinrich Rohrer created the scanning tunneling microscope here. As a DIY enthusiast, I quickly found myself in my own quest to build a better setup. The result was a US $300 modular and motorized microscope that combines my three favorite adulthood hobbies: Arduino, Raspberry Pi, and Lego.

Taking a photo of a microfluidic chip is not easy. The chips are typically too big to fit into the field of view of a standard microscope, but they have fine features that cannot be resolved using a regular camera. Uniform illumination is also critical because the chips are often made of highly reflective or transparent materials. Looking at publications from other research groups, it's obvious that this is a common challenge. With this motivation, I devoted some of my free time to designing a multipurpose and compact lab instrument that can take macro photos from almost any angle.

My first prototype was a Raspberry Pi camera module mounted on a stage that could be moved in three dimensions using the mechanisms of linear stepper motors from old CD-ROM drives. The Raspberry Pi camera was an ideal choice because it allows the manual adjustment of critical parameters like ISO settings and exposure time. I carefully removed the plastic casing holding the lens, revealing the CMOS image sensor, and engineered a delicate mechanism to move the lens back and forth in fine steps so I could take high-magnification macro photos. The setup worked well for a while, but it was fragile. I broke the lens mechanism and damaged the image sensor several times by accidentally forcing the moving parts beyond their limits.

I decided to take a different approach. I removed the lens entirely from the Pi camera. Then I took the objective lens from a low-cost USB microscope and mounted it on another CD-ROM linear actuator so that the objective lens could move back and forth along the optical axis of the Pi camera. I built a housing from Lego bricks to shield the camera's exposed sensor.

However, this attempt resulted in nothing but an appreciation of the high price tag of the linear stages used in microscopes: The travel distance of the CD-ROM actuator was too short to achieve a wide magnification range.

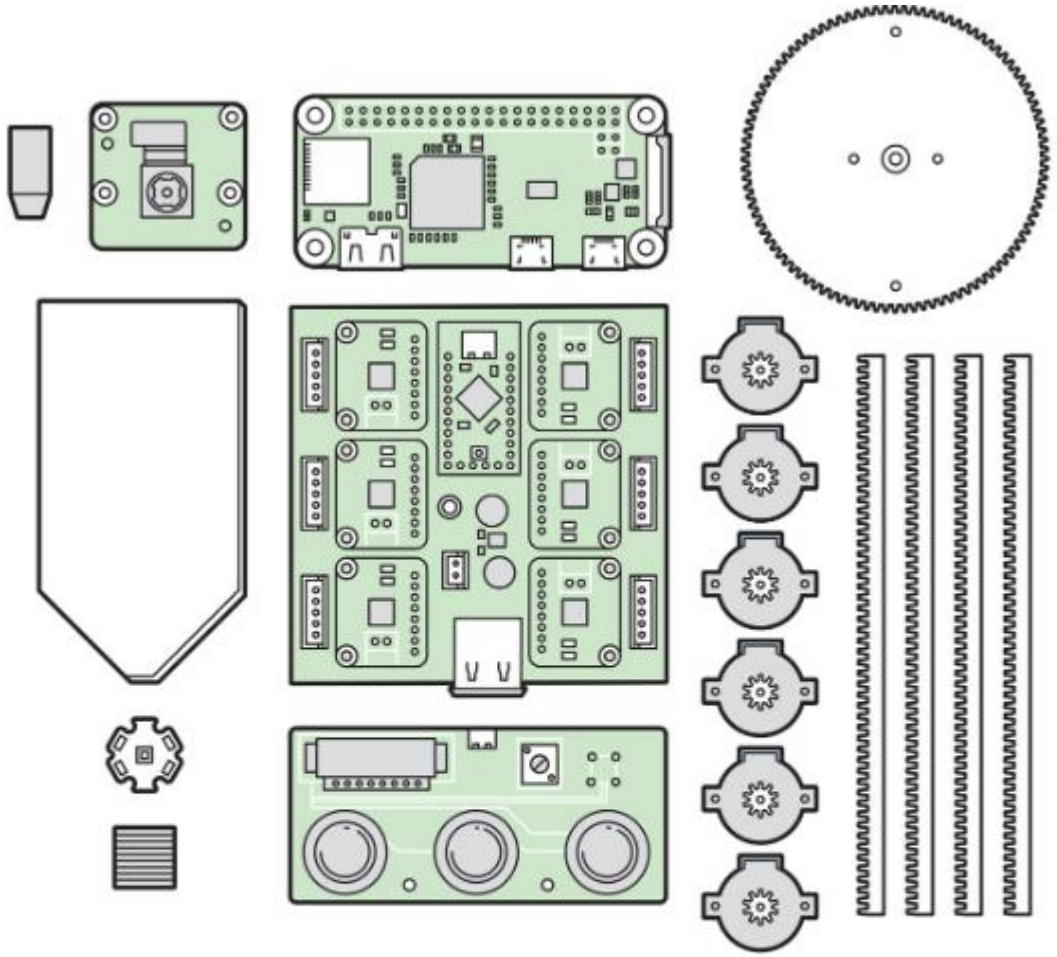


Illustration: James Provost

Mixed Materials: The imaging microscope design uses a potpourri of technologies and materials, including Lego pieces for its main structural components and 3D-printed cogs and racks to drive its moving parts. Stepper motors, which allow for precise movements, are powered by a motor driver board and controlled by an Arduino board. A Raspberry Pi Zero and Pi camera module are used to capture images. The original design incorporated custom-made control boards and parts printed on a high-resolution printer, but prior to public release the microscope was redesigned to be assembled with off-the-shelf boards and parts that could be printed on less expensive, low-resolution printers.

I switched to a lead-screw mechanism used in 3D printers. Instead of commonly used 8-millimeter-diameter threads, shafts, and bearings, I used 3-mm-diameter components to keep things compact. Also, moving the objective lens caused problems in eliminating stray light, so I decided to move the camera sensor instead. I built a stage that allowed the object being imaged to be moved along the x and y axes and rotated. In total, I wound up with six miniature stepper motors with gearboxes that allow me to move the stage, tilt the microscope, adjust its distance to the object, and focus the image.

I often design my own Arduino boards for a more compact implementation. This time, I designed a board measuring 18 by 18 mm and featuring an ATtiny84 microcontroller and a DRV8834 [PDF] stepper-motor driver. The setup gave

surprisingly good image quality, for not only beauty pictures of chips but also for examining features with dimensions of a few micrometers, and even as a digital goniometer for measuring contact angles. I had started the project for a specific need, but it became clear to me that this could be a multipurpose imaging system that anyone can assemble and use at home or school.

IBM and my managers supported me in publicly sharing the assembly instructions. However, as I prepared the instructions for public releases, several issues started bothering me. I had built everything using a state-of-the-art 3D printer and a fully equipped mechanical workshop. Also, the small stepper motors I used were expensive and not available in popular hobby electronics stores. Programming the ATtiny84 via a dedicated ISP programmer was certainly not as easy as programming commercial Arduino boards with a USB port. I went back to the drawing board and redesigned everything using easily accessible components, for example Arduino boards and stepper-motor drivers from Adafruit Industries, and 28BYJ-48 stepper motors, which can be found anywhere for a few dollars. I also replaced the LED-matrix light source with a more maker-friendly and lower-cost version. I bought an LED backlight module from Adafruit for $3 and attached a high-power LED. The intensity was slightly lower than that of the original LED matrix but the uniformity was pretty good for both reflected- and transmitted-light microscopy. For the new linear actuators, I combined "sliding" pieces from Lego with a rack-and-pinion gear combination that I designed using FreeCAD's gear toolbox and printed using my personal Creality Ender 3 Printer. The new design worked as well as the previous one, if not better.

There are probably still many things that could be improved, and I hope this prototype persuades other makers to try new and better ideas. Could it replace a laboratory microscope? Maybe not, but it's a great solution for budget-constrained schools, which is why we have made the instructions open source for everyone to access and enjoy.

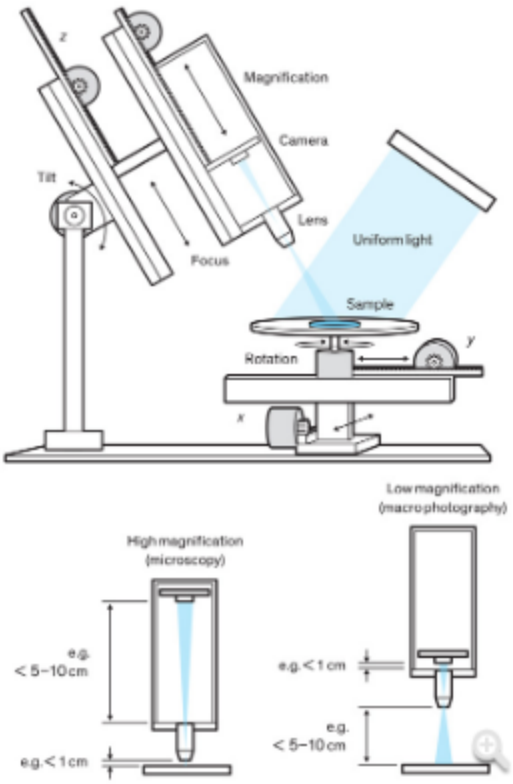


Illustration: James Provost

Perfect Angle: The Lego microscope allows for a sample to be placed under uniform illumination provided by an LED backlight module. The sample can then be moved forward, back, left, and right and also rotated to find the desired view. The microscope body can be tilted up and down, and its proximity to the sample and focus adjusted as well to provide different degrees of magnification [bottom]. The focus is adjusted by moving a lensless camera module within a Lego housing, altering its distance from the objective lens at the base of the housing.

7 VCs talk about today's esports opportunities

By Eric Peckham

Even before theCOVID-19 shutdown, venture funding rounds and total deal volume of VC funding for esports were down noticeably from the year prior. The space received a lot of attention in 2017 and 2018 as leagues formed, teams raised money and surging popularity fostered a whole ecosystem of new companies. Last year featured some big fundraises, but esports wasn't the hot new thing in the tech world anymore.

This unexpected, compulsory work-from-home era may drive renewed interest in the space, however, as a larger market of consumers discover esports and more potential entrepreneurs identify pain points in their experience. To track where new startups could arise this year, I asked seven VCs who pay close attention to the esports market where they see opportunities at the moment:

- Peter Levin, Griffin Gaming Partners
- Beth Ferriera, Firstmark
- Ethan Kurzweil, Bessemer Venture Partners
- Jens Hilgers, BitKraft Ventures
- Doug Higgins, Sapphire Sport
- Rick Yang, NEA
- Kevin Baxpehler, Remagine Ventures

Their responses are below.

Peter Levin, Griffin Gaming Partners

Which specific areas within esports are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?
Everything around competitive gaming is of interest to us. With Twitch streaming north of two BILLION hours of game play thus far during the pandemic, this continues to be an area of great interest to us. Fantasy, real-time wagering, match-making, backend infrastructure and other areas of 'picks and shovels'-like plays remain front burner for us relative to competitive gaming.

What challenges does the esports ecosystem now need solutions to that didn't exist (or weren't a focus) 2 years ago?
As competitive gaming is still so very new with respect to the greater competitive landscape of content, teams and events, the Industry should be nimble enough to better respond to dramatic market shifts relative to its analog, linear brethren. A native digital industry, getting back "online"'will be orders of magnitude more straightforward than in so many other areas.

Do you see opportunities for VC-scale returns in esports companies focused on team ownership and/or content creation as opposed to development of a software product?
Team ownership was never a consideration for our fund.

What startups do you wish to see in this space but don't yet?

Native cross-platforming plays that tap into the social and ambulatory nature of gaming are of interest to us. We're also looking for the killer app that expands the aperture with respect to onboarding more female gamers. There is a lot of ceiling left with this demographic and we will continue to seek out the right vehicles with which to address it.

How has the COVID-19 lockdown and corresponding surge in esports viewing impacted this space?
The COVID-19 pandemic has collapsed the window within which the broader, more traditional fan of sport got exposure to esports. Whether it's EA's FIFA Soccer on NBC, Rocket League, NBA 2K and Madden NFL 2020 on ESPN, virtual F1 racing on NBCSN and virtual horse racing on ITV, tens of millions of sports fans tuned in out of sheer lack of traditional programming or the novelty of virtual competitive gaming. Topgolf-owned World Golf Tour's virtual golf app and related content has seen an unprecedented surge amongst stranded golfers around the globe. People are competing against one another and creating virtual "golf clubs" to coordinate tournament play and recapture lost social moments from the golf course. Regardless, people are talking about it, pundits are writing about it, podcasters are podcasting about it. It's a thing and the genie is way the hell out of the bottle.

Beth Ferreira, Firstmark Capital

Which specific areas within esports are most interesting versus least interesting to you right now as a VC looking for new deals?
What is exciting about this market is that we are still in the early days of esports and there is lots of opportunity. As a VC, the areas I am most interested in are companies enabling monetization such as data and analytics, training (Statespace is in FirstMark Capital's portfolio) and fan networks, to name a few.

To what extent do you expect the surge in gaming and esports viewing during the COVID-19 lockdown will impact startup opportunities in esports? Has it changed your interest in the space?
The surge in viewership is certainly creating strong tailwinds for esports, with increased viewing and new participants joining. As a result, we are seeing ESPN and other traditional broadcasters increase the airing of esports and some traditional brands spending more advertising dollars in the category. As esports develops into a strong ROI channel, this will spur even more innovation and monetization opportunities in the space.

What startups do you wish to see in esports but don't yet?
The most exciting startups will be the ones that have not been imagined yet. In the meantime, new streaming platforms and companies formed around building community and monetizing fan engagement will be exciting to see.

Ethan Kurzweil, Bessemer Venture Partners

Which specific areas within esports are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?
While our gaming practice is as active as it's ever been, our esports roadmaps are far more focused these days. There are three areas in particular where we're spending time: data platforms, betting and digital assets. One interesting esports category right now are the tech platforms tapping into data from players and publishers. If you can understand players' behaviors across multiple game sessions and different games, there's a world of opportunity to build an identity layer in gaming that can improve player performance and social mechanics. One example is the product Blitz.gg (part of our portfolio company TSM), which has become an indispensable product for League of Legends players around the world. We're also continuing to spend time with founders building products to facilitate esports betting and marketplaces for digital assets within games.

When it comes to the less interesting aspects of esports, it's important to remember that the industry is largely controlled by publishers. The other major esports categories: teams, tournament organizers, leagues, youth

athletics are all as successful as the AAA game studios/publishers want them to be. In the team spaces specifically, Bessemer is an investor in Team SoloMid ("TSM"). In the years to come, we expect there to be a phase of "consolidation and collaboration" in the esports world. Unprofitable teams won't make it and the remaining marquee organizations will need to implement collective bargaining, players' unions and other mechanics that make the major professional sports leagues successful today. Without this cooperation among teams, eSports will not reach its full monetization potential with sponsors, media distributors and publishers. Even the NFL, NBA and other major leagues took years, if not decades, to self-organize in a manner that maximized earnings for all stakeholders.

What challenges does the esports ecosystem now need solutions to that didn't exist (or weren't a focus) 2 years ago?
As the industry has grown in recent years, the audience has expanded significantly, with audience numbers as large as Netflix and ESPN. The fundamental problem with the esports business is that it's not easily run like a business at all! The NFL thinks about making money for NFL owners, the LoL commissioners don't think about that at all — they think about getting more people to play League of Legends. The result is that the industry has become very fragmented, so there is a need for an infrastructure to support the business of the esports economy. Take Major League Baseball for example: Commissioner Rob Manfred runs the league like a business where his goal is to maximize revenue for players, coaches, owners and all other industry participants. The challenge is figuring out a win-win for the publishers to make the league a profitable, scalable, growing entity, as opposed to a tiny initiative within their marketing division. Beyond that, teams need to move to collective bargaining to increase their negotiating power against the publishers.

I also think there needs to be more thoughtfulness to player development and player career tracks. When players have a path they can follow and generate income and standing along the way, esports will start to be viewed as more of a legitimate career similar to other professional sports. We're already beginning to see high school and college teams pop up, and we expect to see natural "career" ladders continue to form in the coming years.

Do you see opportunities for VC-scale returns in esports companies focused on team ownership and/or content creation as opposed to development of a software product?
Yes, and we have invested in TSM for that reason. However, it's definitely a narrow path, because you need to create such a compelling brand and a strong, enduring relationship with your audience. The thesis that we see playing out is that modern teams will expand beyond player operations and content creation. For that reason, TSM has branched out in the past years and is just as much of a software company as it is an esports team and content creator. You need all three (brand, team success, software) to create a strong moat for the business. We believe they're building a model for what the future of a sports franchise looks like — equal amounts of software engineers and players/streamers/content creators.

What startups do you wish to see in this space but don't yet?
I'd love to see companies that are making esports more accessible to watch for the average fan. Right now, the very popular casual games aren't very high on the watchability scale, and the most popular games — e.g., League of Legends on Twitch — are hard to follow for amateur or casual gamers. I'd be interested to see companies creating games that are more fun to watch and easy to play for the casual gaming audience – expanding the reach of the esports industry beyond just the hardcore professional gamers.

I think it would go a long way toward making esports sustainable if we created a structure to let another party run the leagues, while still meeting the publisher's objectives and ensuring they can monetize. This infrastructure would help develop players and run the league — with a community of gamers at various levels. There are many opportunities to participate in building this league infrastructure, if the major publishers would give up just a tiny bit of control. As investors in Twitch, we experienced this type of symbiotic growth first hand in their early days. Publishers allowed Twitch to thrive while also giving all of the games an outlet to bring in new fans and players – the growth has benefitted everyone and facilitated the boom in gaming/streaming we see occurring today.

Jens Hilgers, BITKRAFT Ventures

Which specific areas within esports are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?
From a thematic perspective, we continue to spend more time with exciting games studios on the one hand; and with gaming infrastructure and platforms that integrate across various IPs on the other. From a geographic perspective, we are paying increasing attention to emerging gaming markets such as India, Middle East and Southeast Asia while we have dominantly invested in North America and Europe to date.

What challenges does the esports ecosystem now need solutions to that didn't exist (or weren't a focus) two years ago?
The ecosystem didn't change in a way that solutions are needed that were not in demand or of benefit two years ago. The biggest challenge for the esports ecosystem remains a structural one on how IP holders, leagues, teams and players are collaborating and interacting through professional sports structures. While time and more experiments at greater scale are providing a valuable new experience to all market participants, it will still take many years for the industry to be at a point where it feels like it's come together in a highly sustainable and beneficial way for all participants.

What startups do you wish to see in this space but don't yet?
I would like to see a platform that serves as a trusted authority to authenticate and validate the identity of an amateur or professional esports player as well as to implement a more holistic approach to combat cheating and toxicity. This platform would be highly useful for the industry at large, and in particular, the tournament organizers and professional teams.

Doug Higgins, Sapphire Sport

Which specific areas within are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?
We take a broad view when we think about the sport market including gaming and esports. That means we're really looking at everything from publishers to infrastructure to global sponsorships, digital health and fitness, betting, software management and everything in between.

One area we have been, and continue to be, skeptical of is the valuations investors are assigning to some of the esport teams. As an institutional investor, it is difficult for us to see the risk-adjusted returns you expect from venture capital for many of these organizations. This is especially true now, with COVID, as teams are suffering from the lack of live events and reduced sponsorship dollars.

We believe that while most investors' attention has been focused on professional gamers, there is a larger, more underserved market with amateurs. Tournament platforms, coaching tools and other enabling technologies, all of which touch the grassroots foundation, will be necessary to engage larger audiences and grow the esport market. With our investment in PlayVS, we've identified a company which has provided structure and access for gamers to engage in organized competition at a young age and technologies that can provide similar value on a broad scale. Finally, companies like Roblox have proven that gamers don't just want to be players, they also want to be creators, and we are very excited about technologies that put the power of game development in the hands of the gaming community, such as our investment Manticore Games.

How will COVID-19 and a recession reshape the market — and the opportunity for startups within it — over the next two years?
COVID is affecting esports like traditional sports since they can not have live events and sponsorship dollars are being reduced. There seems to have been a boost to gaming overall as everyone is sheltering in place, and we

believe over the next few years that you'll see virtual, esports events becoming more popular — especially if there is a new generation of infrastructure technologies that can help these events run more seamlessly, and fan immersion technologies to enhance the viewing experience.

What startups do you wish to see in this space but don't yet?
We continue to be most interested in enabling technologies for the gaming industry. For example, we continue to look for coaching and player-development technologies that are truly unique and innovative. We also believe that there remains a significant opportunity for infrastructure technologies — companies with solutions that minimize latency issues, address security concerns or provide ways to immerse fans in the experience above and beyond watching a gamer's live stream. Transactional solutions are another area we're watching closely.

Rick Yang, NEA

Which specific areas within esports are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?

Interesting areas:

- New scalable and creative ways of monetization for esports
- Ideas at the center of the Venn diagram of e-commerce, media, social, and gaming
- Broadly, enabling mass consumer gatherings for live events within gaming worlds a la Travis Scott's Astronomical (but apply this to everything —religious gatherings, education, etc.)

Uninteresting areas:

- Platforms for how to get better at X game
- Traditional ideas around esports influencers

What challenges does the esports ecosystem now need solutions to that didn't exist (or weren't a focus) two years ago?
The market isn't mature enough to try and mimic revenue streams and ideas from traditional sports successfully, which was the initial push by the space to gain credibility

What startups do you wish to see in this space but don't yet?
I don't know what shape these might take (which I think is the point of this question), but I hope to know it when I see it:

- Companies that are able to create a completely proprietary, high-value set of data for this ecosystem
- Companies that will be able to completely re-imagine what a live esports event is and how it is experienced (both in person and remotely)

Kevin Baxpehler, Remagine Ventures

Which specific areas within esports are most interesting to you right now as a VC looking for deals? Which areas are the least interesting territory for new deals?
At Remagine Ventures, we mainly focus on software solutions, addressing the needs of esports fans and casual gamers, and less on the professional players, teams or leagues. Currently we are looking at esports data solutions, monetization/innovative advertising products, viewer engagement tools, innovative broadcasting and publishing or OTT/infrastructure solutions.

We like the trend of how esports as a cultural phenomenon is crossing over into other industries, e.g., music, e-commerce, content and social. With 5G rolling out, we also expect mobile gaming to reach new levels.

We don't invest in teams or leagues.

What challenges does the esports ecosystem now need solutions to that didn't exist (or weren't a focus) twi years ago?

1. Clear league and tournament structures. Currently in some titles it is still fragmented and complicated, some publishers take control, some franchise and some keep it open.
2. Revenue — while esports is increasing in popularity, it is still small compared to most other sports when it comes to attracting sponsorship, media rights and advertising funds. Most blue-chip companies still struggle to engage with FPS games since it still lacks broad social acceptance. The esports industry is not mass-marketable yet.
3. New ways of monetization: advertising and pay models in the traditional way don't fully work in the community.
4. There is a lot of data we don't have access to as most publishers don't have public APIs and the streaming platforms are selective in what data they share.

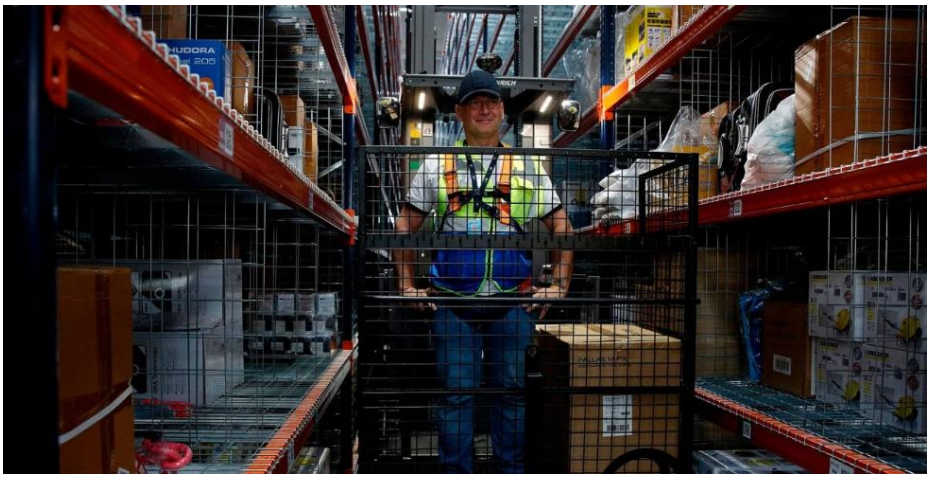
Do you see opportunities for VC-scale returns in esports companies focused on team ownership and/or content creation as opposed to development of a software product?
We're mainly focused on software, ideally with some tech differentiation. Furthermore, given the structural challenges most leagues and tournaments face we currently do not invest in teams. That said, we like how some teams are building lifestyle brands, e.g. 100 Thieves or FaZe Clan.

There certainly are opportunities within content creation. Our portfolio company Minute Media owns DBLTAP, for example. One of our investors acquired the domain www.esports.com and is re-launching its platform and brand. Mostly we look at how technologies can help create or discover content, e.g., automatic video summaries or our investment Novos, a technology-driven gaming-training platform.

What startups do you wish to see in this space but don't yet?
We are looking for new and innovative ways to collect and analyze data or to advertise. Technologies like computer vision and machine learning can impact how the consumer plays, interacts, learns or watches esports. We also don't have a common currency yet of how to measure reach and engagement, which is needed to measure attribution and attract more money.

Amazon worker-activists form international organization to demand change in warehouses

By Megan Rose Dickey



Amazon workers across the world are formalizing their activism with the creation of the Amazon Workers International. Its first action is a letter to Amazon CEO Jeff Bezos and Amazon Director of UK Customer Fulfillment Stefano Perego in which the group demands the company makes permanent certain steps Amazon has implemented amid the COVID-19 pandemic.

In light of the global health crisis, Amazon made some positive changes — changes that workers want to ensure stay long beyond the pandemic. Those changes include an increase of $2 per hour and an extra five minutes' worth of break time. The company also got rid of productivity feedback, which incentivizes workers to do more, faster.

"They're talking about taking that away," Christian Zammarròn, an Amazon warehouse worker in Chicago, told TechCrunch. "I don't think they should take it away. These are things we need not just during a pandemic but all the time."

As of April 24, Amazon said it would extend the increased hourly pay through May 16.

"We've extended the increased hourly pay through May 16," Amazon spokesperson Lisa Levandowski told TechCrunch. "We are also extending double overtime pay in the U.S. and Canada. These extensions increase our total investment in pay during COVID-19 to nearly $700 million for our hourly employees and partners. In addition, we are providing flexibility with leave of absence options, including expanding the policy to cover COVID-19 circumstances, such as high-risk individuals or school closures. We continue to see heavy demand during this difficult time and the team is doing incredible work for our customers and the community."

Amazon Workers International formed after about 40 Amazon warehouse workers around the world gathered in Madrid a couple of months ago. The organization represents Amazon workers from six countries: Germany, Poland, Spain, France, Slovakia and the United States.

"Each country has its own laws but from our conversations at our convenings, we just see that we all have basically the same issues, Zammarròn said. "In Europe, especially, they've seen the necessity for international solidarity and how that makes them stronger."

While Zammarròn's list of grievances with Amazon is long, what tops his list is retaliation.

"That needs to end," he said.

Toward the end of March, warehouse workers in Chicago went on a number of safety strikes in "response to Amazon's complete disregard for our lives with positive COVID-19 cases spreading through our warehouse,"

Zammarròn, who helped organize the actions in Chicago, said. “They’ve been retaliating these past weeks trying to scare us and trying to shut us up. We’ve been fighting back.”

Regarding retaliation, Amazon said in a statement to TechCrunch that it respects the rights of employees to protest and recognizes their legal right to do so, “but these rights do not provide blanket immunity against bad actions, particularly those that endanger the health, well-being or safety of their colleagues.”

In March, Amazon fired worker-activist Chris Smalls, who helped organize a protest at a warehouse in Staten Island, New York.

“We did not terminate Mr. Smalls employment for organizing a 15-person protest,” an Amazon spokesperson told TechCrunch. “We terminated his employment for putting the health and safety of others at risk and violations of his terms of his employment. Mr. Smalls received multiple warnings for violating social distancing guidelines. He was also found to have had close contact with a diagnosed associate with a confirmed case of COVID-19 and was asked to remain home with pay for 14-days, which is a measure we’re taking at sites around the world. Despite that instruction to stay home with pay, he came onsite further putting the teams at risk.”

NY Attorney General Leticia James has since said she’s considering taking legal action against Amazon. Then, more recently, a group of Amazon workers at a fulfillment center in Minnesota protested the firing of a worker who stayed home for fear of giving her kids COVID-19. Shortly after the protest, Amazon reinstated the worker.

Already, Amazon warehouse workers have filed unfair labor practice charges and have more on the way, Zammarròn said. Still, he said he’s already seen Amazon change a lot of safety policies. Amazon started providing masks, taking temperatures and providing hand sanitizer and disinfectant wipes.

“And maybe the biggest thing they did was they slowed down the work,” he said. “They decreased the amount of work so that actually helps in maintaining some social distancing. And these were immediate changes after our safety strikes. Before that, they were basically operating as if everything was normal.”

But workers still want to make it known that their coworkers are continuing to get sick. In the letter, workers say Amazon lacks in the transparency department. Amazon, however, maintains that when it confirms a case of COVID-19 among workers, it communicates that to other people who work at that same site.

This letter of demands is just the first of what we’re seeing from AWI.

“Our international solidarity will definitely grow,” he said. “This is a very important aspect of what we’re doing and what any worker movement should do, which is expressing coordinated international demands and coordinated international actions.”

VC appetite for AI startups holds up in Q1 despite lackluster exit volume

Today we're taking our final look back at Q1 venture capital through the lens of AI-focused startups. New data out this week paints a mixed picture of the AI startup landscape. Venture dollar volume in Q1 was pretty good, though there was weakness in certain startup stages. Exit data was weak, however, and some Q1 numbers were juiced by a single deal.

AI-focused startups have grown past their history as the hot new thing (remember when every new tech company was doing AI for 45 minutes?) into a more mature niche; TechCrunch has spent a reasonable amount of time digging into their economics, and just this week a new, $180 million AI-focused fund caught our attention.

In the post-hype days, then, let's check in on what global AI startups got done with investors in Q1. We're leaning on this report from CB Insights, which breaks down the quarter's numbers for us. Let's pick them apart and see what we can divine concerning the future.

AI Q1 2020

To set the stage, venture capital investment into AI-focused startups has generally risen on a global basis for years. Indeed, deal and dollar totals have risen year-over-year from 2015 through 2019. Indeed, 2019's Q2 and Q3 saw record AI startup venture dollar volume ($8.45 and $8.47 billion, respectively), per CB Insights .

Q1 2020 effectively matched those record venture dollar results with $8.42 billion in capital raised, though with a key caveat. Namely that Waymo's huge Q1 round, a multi-billion deal, helped improve the results. Without the Waymo round, Q1's venture totals were closer to $6 billion, a strong result but nothing like record levels that 2019 delivered.

Falling venture dollar volume for a startup niche isn't the end of the world, and as Q1 2020 saw roughly Q4 2019's dollar volume, should AI startups be at all concerned? Perhaps, but for a different reason. Q1 2020 AI startup deal volume was the lowest since Q4 2018, meaning that an unimpressive (once adjusted for Waymo) venture dollar result was paired with a notable decline in deal volume in the first quarter of the year.

That's not bullish, per se, even if around $6 billion in investment in around 500 global deals for AI startups is also not precisely bearish itself. It's not likely we're seeing much COVID-19 impact in these numbers—the global lockdown snowballed towards the end of the quarter and venture deals take a moment to close and are often announced far later. Q2 2020 could tell us much more about the impact of COVID-19 in AI startup investment. Q1's early indicators, however, aren't exactly encouraging.

Two more things before we go. First, the United States saw its share of AI startup deal volume rise to 41% in Q1 2020, up from 37% in Q4 2019 and 39% in Q1 2019. The country used to see a higher percent of global AI deals (51% in Q1 2017, per the CB Insights report), meaning that America's small gains are still far under historical highs. That said, the country with the next highest share was China, which managed just 10.5% in Q1 so it's hard to be too irked at the domestic result.

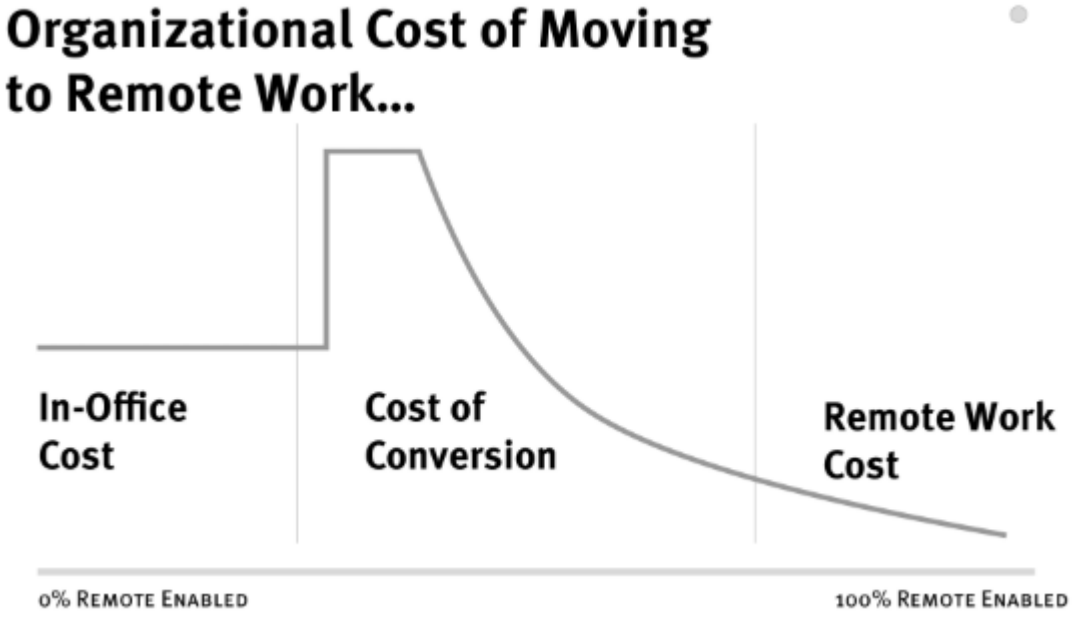
And second, AI startup exits were weak in Q1. This should not surprise. The exit window lasted about two venture-backed IPOs in the United States before shutting. In what CB Insights calls an "11-quarter low," there were just 29 global AI exits in Q1 and zero IPOs, the worst result since Q2 2017, though that quarter did include an IPO.

As we noted at the top, it was a mixed quarter. One cannot dismiss 500 global deals and north of $8 billion in investment (including the Waymo check), even if once we peer into the numbers there are weaknesses to be found, like falling Seed volume in recent quarters amongst AI startup and lackluster exits. Like with many bits of Q1 data, all this feels a bit transitory. What we really want to know is what is happening now that the COVID-19 economy is truly here.

By Sam Lessin

A shift to remote work at companies was underway even before the Covid-19 outbreak. New startups were being born that were fully "remote from the start." Larger companies were experimenting with remote work to access talent outside major hubs.

But while the shift had started, few firms had fully embraced the change. Moving to a remote-work culture from an office culture requires an investment of culture, energy and money far above and beyond what most companies were willing to commit to, pre-Covid.



The last few months have, of course, changed all this. Nearly all knowledge-work–based companies have been forced to iterate through processes and technology to actually put at-home work into practice. For many companies, having been forced to make the investment, they are now finding that the strategy is working—and offers a very enticing template for how to continue in the future.

Many companies are not going to return to pre-Covid work patterns. The implications of that sea change are enormous. Here are a few of the most important things to keep in mind about the new reality of remote work:

*** People are not going to return to going to offices five days a week, which is going to crush commercial real estate and adjacent businesses.**

In an informal poll I recently ran of 500 participants, less than 20% of people thought they would return to working in an office five days a week in the future. More than 60% thought they would be in an office three days or fewer a week. This poll was by no means scientific, but I do believe it is directionally indicative of a major shift we will see in work culture.

There are reasons for teams and individuals to want to meet in person periodically. But if people don't want to go back to the office routine, and companies benefit from work at home (more on this later), then there is no way that office culture will reemerge as it was on the other side of this episode.

The standard will flip to mostly remote work punctuated by in-person collaborations and meetings.

Needless to say, owners of commercial real estate, and businesses that rely upon high densities of daily workers in offices, are going to suffer a lot. So, too, will businesses like restaurants, cleaners and so forth that rely upon office cultures and downtown density of daily workers.

The model of long-term corporate leases and expensive build-outs for commercial real estate was already a deeply threatened model. But post-Covid, it simply doesn't make sense as a business. Co-working is also not going to make very much sense unless the providers move away from desk and space rentals.

Instead, you can imagine teams renting shared generic space at defined times weekly or monthly, or hosting periodic global-style conferences using hotels and convention centers more frequently. This could be a new class of real estate or the reconstitution of what already exists. But any way you slice it, the physical footprint needed for office work is going to shrink if the number of office days declines a lot. And it might be that home design will change as well to better accommodate home workers.

*** A flattening competitive curve for jobs, opening opportunity globally and likely lowering wages.**

When some people work remotely but most people work in person, the people who are remote are at a decided disadvantage in succeeding at their jobs. When everyone is working remotely, that flattens the playing field, and everyone is equally well positioned to succeed.

What this means for the global talent pool is that many people will have way more access to job opportunities and greater prospects for success. This forced move to remote work, in a sense, is going to allow companies to access way more talent.

This will be good for creating opportunities for people worldwide, but it also likely means that the premium engineers have commanded in certain cities will drop. For companies, being forced to pay the one-time tax of moving to remote work could be a long-term benefit where they get access to better talent at lower costs.

For individual workers, of course, the impact is going to be interesting. For any engineer outside the core markets or with a nontraditional background, the move toward remote work will be positive. For certain engineers in the core markets, the net impact will likely be akin to the move toward the outsourcing of manufacturing a generation ago—they will lose pricing power and inside access to knowledge and opportunities.

*** An increased focus on measuring and systematizing work so that it can be done remotely at high efficiency and quality.**

The place where the shift to remote work is hardest is where processes are poorly documented and teams work collaboratively without structure. This is unavoidable no matter how much teams deploy and learn to use tools like Slack and Zoom.

What this means is that the shift to remote work is going to bring a shift toward more structured work processes and process documentation. Teams that used to work nearly ad hoc are going to have to work hard to make sure they clearly define and measure the tasks they ask of people, so that remote workers don't need to constantly ping each other with questions.

At Fin Analytics, the company I have been building for the last few years, we see this very clearly with operations teams. Any processes that we used to do casually, or any questions that we used to answer by raising a hand and checking in quickly with a manager, are rapidly becoming highly process driven and structured in this remote work situation.

Similarly, training—which could be done nearly ad hoc by in-person osmosis, spending time with co-workers—must shift to more formal documented and followed processes.

This move toward documentation, standardization and measurement is related to the flattening of the competitive curve. It isn't just that everyone will be working remotely. It is that jobs themselves will change so they can be done effectively from anywhere.

*** Higher remote-work corporate profitability based on lower wages for knowledge-based jobs and lower real estate costs.**

If what I suggest above comes to pass, the move toward remote work will mean that knowledge work–based firms will become more profitable.

This isn't just because firms will be able to avoid expensive real estate outlays. It is also because of changing patterns of access to talent and job standardization.

As noted, to the extent that this period greatly expands the talent pool, then wages should drop, making firms more profitable.

To the extent that job processes become more documented, measured and standardized, you can expect that the costs of training and turnover will decrease. That again will lower the pricing power of knowledge workers and increase firm profitability.

*** Suburbs and cities will likely decline and exurbs will rise.**

Let's imagine that people stop going to work in an office daily, but instead are checking in to an office or going to work with co-workers only a few times a week or month. Does that change where people want to live? My sense is that it absolutely will.

Some people are floating the theory that the long-term impact of Covid-19 will be a flight from big cities and a rise of the suburbs. This is after a major shift from trends of the last 20-plus years, when technology made cities more desirable.

I think this is wrong. Commuting-oriented suburbs are not the answer. People will want to return to the real country and live hours, not minutes, outside hubs.

My personal view is that we will see new forms of rural living where costs are low and land is abundant, and small towns might become the new social and connective tissue.

While any sort of shift of this magnitude will be very slow, it also would greatly change the logistical patterns in the U.S. and draw into question a lot of the current business models of companies like Uber, which require population density to work.

Conclusion

The shift from office cultures to truly remote cultures might have been a good idea even pre-Covid. But getting to that end state required organizations to invest an enormous amount up front—in tech, process and training—for the long-term advantages of remote work.

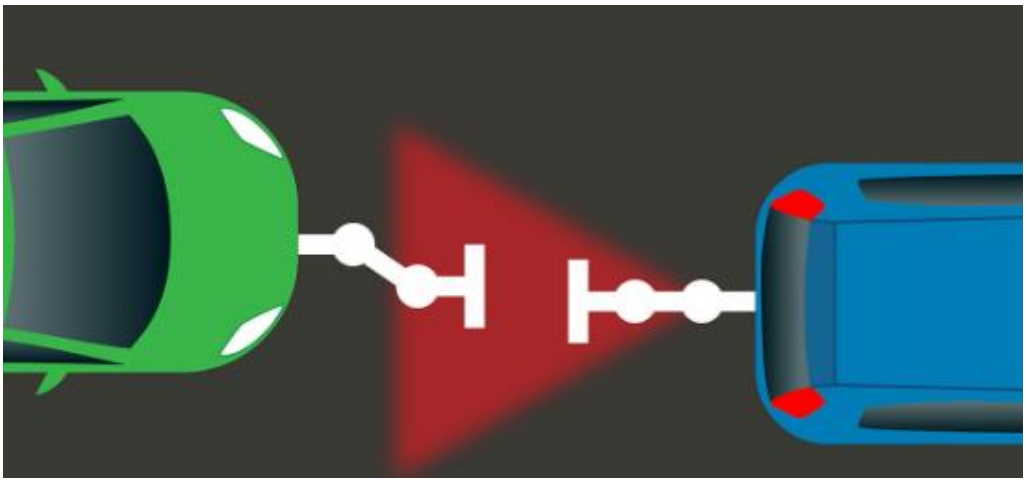
Nearly every company in the world, in the last few weeks, was forced to make the investment in remote work and overcome the up-front cost. Now that many have paid that cost, there is no going back.

The Takeaway

The trend toward remote work may have been underway already, but in the last several weeks the Covid-19 crisis has forced companies to fully commit to the necessary investments in tech, process and training to make remote work a permanent feature of their businesses. Companies won't go back to the pre-coronavirus office culture.

On-the-road peer-to-peer charging depends on steerable booms to make the connection

By Philip E. Ross



Jet fighters can't carry a huge tank of fuel because it would slow them down. Instead they have recourse to air-to-air refueling, using massive tanker planes as their gas stations.

What if electric cars could do the same thing, while zooming down the highway? One car with charge to spare could get in front of another that was short of juice, and the two could extend telescopic charging booms until they linked together magnetically. The charge-rich car would then share some of its largesse. And to complete the aerial analogy, just add a few big "tanker trucks" bearing enormous batteries to beef up the power reserves of an entire flotilla of EVs.

The advantages of the concept are clear: It uses a lot of battery capacity that would otherwise go untapped, and it allows cars to save time in transit by recharging on the go, without taking detours or sitting still while topping off.

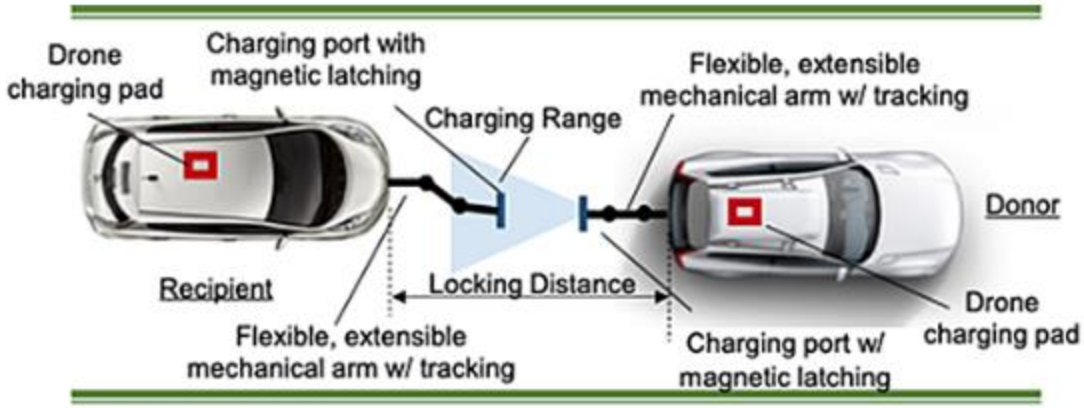
Yeah, and the tooth fairy leaves presents under your pillow. We're too far into the month for this kind of story. Right?

Maybe it's no April Fools joke. Maybe sharing charge is the way forward, not just for electric cars and trucks on the highways but for other mobile vehicles. That's the brief of professor Swarup Bhunia and his colleagues in the department of electrical and computer engineering at the University of Florida, in Gainesville.

Bhunia is no mere enthusiast: He has written three features so far for IEEE Spectrum (this, this and this). And his group has published their new proposal in arXiv, an online forum for preprints that have been vetted, if not yet fully peer-reviewed. The researchers call the concept peer-to-peer car charging.

The point is to make a given amount of battery go further and thus to solve the two main problems of electric vehicles—high cost and range anxiety. In 2019 batteries made up about a third of the cost of a mid-size electric car, down from half just a few years ago, but still a huge expense. And though most drivers typically cover only short distances, they usually want to be able to go very far if need be.

Mobile charging works by dividing a car's battery pack into independent banks of cells. One bank runs the motor, the other one accepts charge. If the power source is a battery-bearing truck, you can move a great deal of power — enough for "an extra 20 miles of range," Bhunia suggests. True, even a monster truck can charge only one car at a time, but each newly topped-off car will then be in a position to spare a few watt-hours for other cars it meets down the road.



Credit Illustration: Swarup Bhunia

Peer-to-peer car recharging, like aerial refueling, uses steerable booms to fashion a transmission channel.

We already have the semblance of such a battery truck. We recently wrote about a concept from Volkswagen to use mobile robots to haul batteries to stranded EVs. And even now you can buy a car-to-car charge-sharing system from the Italian company Andromeda, although so far no one seems to have tried using it while in motion.

If all the cars participated (yes, a big "if"), then you'd get huge gains. In computer modeling, done with the traffic simulator SUMO, the researchers found that EVs had to stop to recharge only about a third as often. What's more, they could manage things with nearly a quarter less battery capacity.

A few disadvantages suggest themselves. First off, how do two EVs dock while barreling down the freeway? Bhunia says it would be no strain at all for a self-driving car, when that much-awaited creature finally comes. Nothing can hold cars in tandem more precisely than a robot. But even a human being, assisted by an automatic system, might be able to pull of the feat, just as pilots do during in-flight refueling.

Then there is the question of reciprocity. How many people are likely to lend their battery to a perfect stranger?

"They wouldn't donate power," explains Bhunia. "They'd be getting the credit back when they are in need. If you're receiving charge within a network"—like ride-sharing drivers for companies like Uber and Lyft—"one central management system can do it. But if you want to share between networks, that transaction can be stored in a bank as a credit and paid back later, in kind or in cash."

In their proposal, the researchers envisage a central management system that operates in the cloud.

Any mobile device that moves about on its own can benefit from a share-and-share-alike charging scheme. Delivery bots would make a lot more sense if they didn't have to spend half their time searching for a wall socket. And being able to recharge a UAV from a moving truck would greatly benefit any operator of a fleet of cargo drones, as Amazon appears to want to do.

Sure, road-safety regulators would pop their corks at the very mention of high-speed energy swapping. And, yes, one big advance in battery technology would send the idea out the window, as it were. Still, if aviators could share fuel as early as 1923, drivers might well try their hand at it a century later.

Source by CrunchbaseNews

We're living through a period of economic, business and personal uncertainty due to the COVID-19 pandemic. It has caused economic downturns and losses on a monumental scale around the world. The ambiguity around the depth and length of the economic slowdown has made it even more difficult for businesses to adapt.

In such times of volatility, it is critical that business leaders remain calm and look forward to the future, rather than making rash decisions in the moment. However, it is also important to act swiftly and adjust strategies in the near-term that will allow businesses to preserve necessary resources.

Small businesses will need to persevere through a temporary depression in most markets. This varies by geography and sector. This is the time to do everything possible to retain cash flow and maintain business operations, employees, product development and plans for future growth. Building a successful company and investing are long-term endeavors.

Here is my advice for venture capitalists and small businesses navigating through this period of unprecedented economic uncertainty.

VCs: Take a deep breath and act honorably
My advice for venture capital investors is to take a deep breath and sustain a long-term view. Remember, for early-stage VC in particular, we're investing in the steady growth and potential of a company over time–10 years or so. While valuations will likely decline and there will certainly be a need for additional capital and support, the economy will rebound eventually.

Additionally, don't be afraid to seek out new opportunities during this time. Again, while it's likely that startups will need extra support, it's also well known that some of the best venture-backed businesses were founded and funded in recessionary times. Examples include Facebook, Microsoft, Nutanix and Electronic Arts.

Remember that entrepreneurs, fellow investors and vendors will have long-term memories. Don't overplay your hand. While you may see the opportunity to extract unheard-of terms, think twice and think as if the tables were turned. It's in your best interest to partner where the relationship is fair and balanced.

Startups: Focus on R&D, people
For entrepreneurs with enough resources to survive 3-12 months of minimal new sales, this should be seen as a time to shift focus to develop a better product, improve automation of internal processes, and keep existing customers well served. This will not only strengthen the business overall, but will also place it in a better position to respond to pent-up demand and resumed competition once economic growth returns.

With that said, it's undoubtedly a very confusing time for employees and managers alike.

Here are some steps to help ensure the well-being of staff and the company as a whole:

Be empathetic.

Reach out to employees, colleagues and investors on a personal level. In these unusual circumstances, people work best with structured processes, familiar routines, and when they truly feel connected, listened to, seen and supported.

In doing so, actively engage and utilize "social enterprise" tools for a work-from-home environment that may endure for months.

Think long term.

Try to act rationally, not emotionally. Base your actions on a clear set of assumptions, including contingency planning, that everyone understands. Keep your eyes on the long-term vision for growth and scale, but take appropriate stabilization and defensive measures in the short term. In addition, remember there are also opportunities to hire better people, do more training and make acquisitions, as well as other "lean forward" tactics. Consider adjusting key performance indicators and evaluations with flexibility, while maintaining rigorous measurement and efficiency moving forward.

Budget and use financial resources strategically.

Review your budget and focus on cash flow with scenario planning alternatives. Then, reallocate budget to top priorities and defer or close lower priority projects and initiatives.

Next, look for creative ways to cut costs by temporarily lowering salaries (starting with your own), deferring salaries or in some cases trading salary for equity options. For this, always check with legal and human resources teams.

Lastly, assess the credit situation with lenders and draw down available credit before it's needed. And, when appropriate, take advantage of cash coming from federal and state programs such as the CARES Act loans from the Small Business Administration.

While it's never easy to pivot quickly due to unforeseen circumstances, now is the time for small-business CEOs to prove themselves as visionary, prudent and trusted leaders to come out of this even stronger.

The path forward

Maneuvering through this historic and challenging time requires adopting the right mindset. While it's difficult to carry on business as usual, it's important to keep in mind that there is a light at the end of the tunnel and actions taken now will impact future success.

Over the long term, the behaviors exhibited, resources deployed, lessons learned and new protocols implemented can enable a significant step-change improvement and lead to a better future for entrepreneurs, employees, investors and their customers.

By Kermit King and Dan Wald

The only certainty about the COVID-19 pandemic is that it will eventually end, and when it does, many of the changes it has brought will recede. Like wildlife returning to Chernobyl, prior conditions will reappear. Consumers will once more shop and socialize, supply and demand will rebalance, and markets will recover. History tells us, however, to also expect some lasting change in the wake of crisis—such as Glass-Steagall after the Great Depression, increased suburbanization after World War II, and heightened security following 9/11. Similarly, in the wake of turmoil, company performance and position can either shift temporarily, or permanently. This outcome depends on the interplay of customers, competitors, and regulators. It also depends, importantly, on the decisive actions companies and their leaders take in the middle of the crisis.

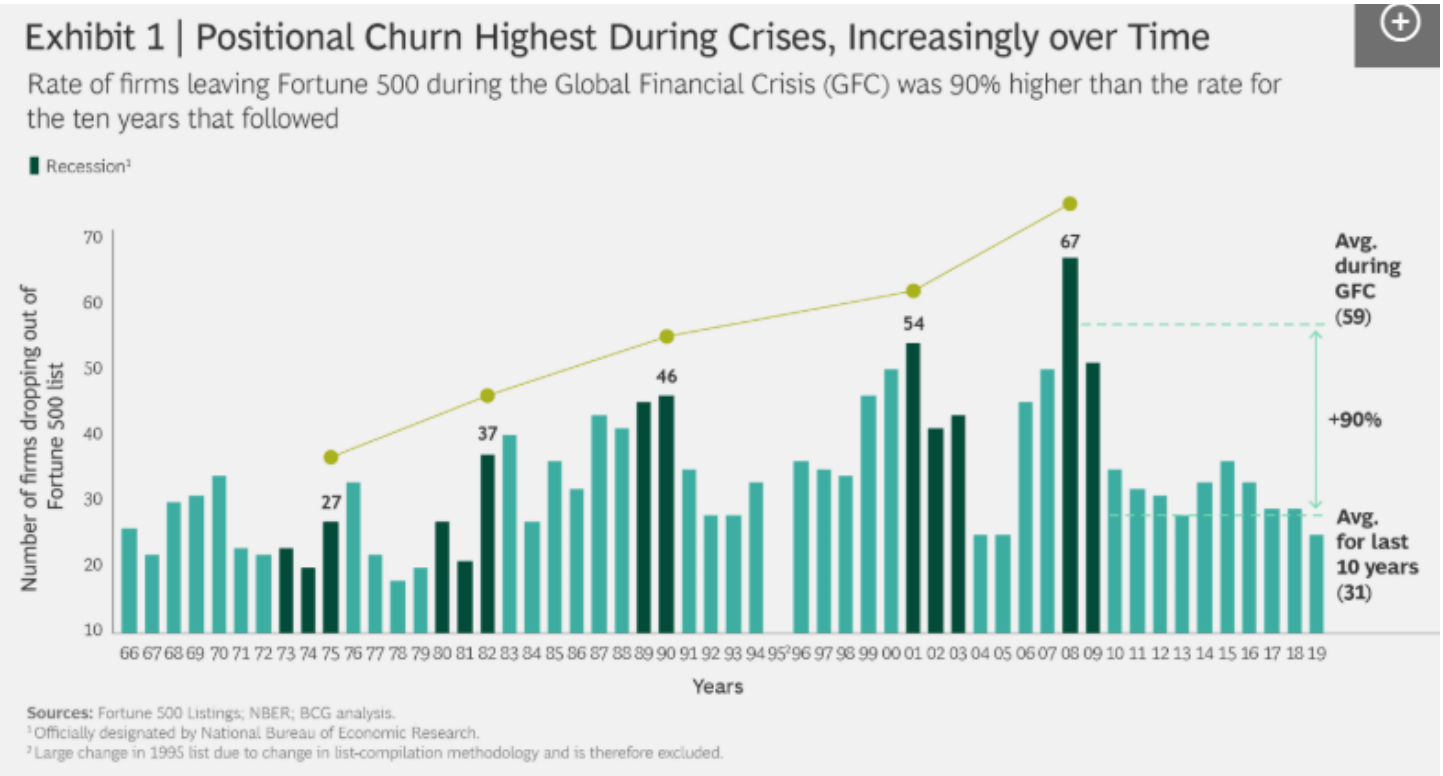
Companies that master both the transitory and the transformational response to a crisis reap long-term rewards. Transitory responses entail rapid actions that are critical for survival, including protecting employees, managing cash, and flexing supply chains to meet demand. But occupying new positions and building new advantages requires transformational moves and investment. In a crisis, when the immediate response can be all-consuming, transformational moves are harder. They are also smarter, and create opportunities to win in the long term.

Two leading US watch manufacturers, Bulova and Waltham, traversed the serial crises of the 1920s to 1940s. Both launched immediate responses, for example, by extending terms to retailers in the Great Depression and by later successfully shifting production to wartime instrumentation. Beyond this, Waltham largely pursued a course of tight cost management, curtailing advertising, innovation, and investment in sales and distribution.

In contrast, Bulova consistently invested in new sources of advantage, acquired multiple domestic and international competitors, and innovated as it spent. During this time, the company launched the industry's first-ever million-dollar advertising campaign, the world's first television commercial, and was an early innovator in electric clocks and clock radios. Bulova's leaders also cultivated close government relationships, selling products to the government at cost, and opening a watchmaking school that employed disabled veterans—all while aggressively lobbying to impose tariffs on imported watches. Bulova became one of the era's ten best-performing stocks, and from 1931 to 1954, its value appreciated by a factor of 24.

Waltham went bankrupt.

Exhibit 1 shows the prevalence of this storyline. Volatility in company position is greatest in times of crisis and has steadily increased with successive crises over the last 50 years. Fortune 500 churn during the last recession was 90% higher than the average of years since.



Bulova's example suggests that winning beyond a crisis requires finding transformational opportunity signals in the midst of transitory noise.

THE FIVE-POINT APPROACH TO TRANSFORMATIONAL RESPONSES
Our experience with companies that have mastered the ability to identify transformational opportunities suggests five points of action:

1. Detect and discern critical shifts.
Stay ahead of the curve by setting up three war rooms: one for customers, one for competitors, and one to consider regulatory issues. Building these cross-disciplinary teams will help companies determine which signals related to demand and competition are most relevant to monitor, which are likely to persist after the crisis, and which reveal opportunity. In a crisis, the detection cycle is fast, and can even occur on a daily basis. In a prior crisis, one cruise company war room monitored credit card spend, detecting timing and patterns of early returning travelers. Currently, a client is looking at road congestion levels in China to discern the shape of the post-crisis rebound.

Such insights must be integrated into all three war rooms to discern patterns of longer-term opportunity. Following 9/11, for example, Qantas was able to guide its expansion plans and gain market share by monitoring customer data in addition to its competitor capacity and routes. CGI, a technology consulting firm, gathered detailed survey results through one-on-one field interviews with a quarter of its customers conducted by local senior executives. The results yielded competitive insights that led to a series of adjacent acquisitions through the downturn from 2007 to 2009, in turn driving 50% of CGI's go-forward growth.

An essential role for the war rooms is to assess which changes are transitory and which are likely to be permanent—and to recommend actions for each. Temporary crisis behavior, like grocery stockpiling, may represent a closing window that requires rapid deployment to capture incremental revenue. More permanent behavior, however, often emerges where a preexisting trend or advantaged offering gets a crisis nudge—pushing consumers to trial new options, or resulting in a shift of cost-benefit tradeoffs. In the current crisis we already see candidates: telemedicine in health care, increased retail click-and-collect, more resilient supply chains, greater caution in travel and tourism,

and normalized remote work. Capitalizing on these more permanent opportunities requires longer bets and capability builds, with historical examples able to inform companies today.

2. Outflank the competition.
As business customers and consumers rapidly react to the terms of crisis, new brand perceptions, purchase behaviors, and demand patterns create competitive openings. Companies that capitalize on these openings faster than the competition can change the field of play in ways that reward beyond the disruption.

In the last recession, cost-conscious buyers began to delay new car purchases in favor of increased DIY maintenance and repair. Auto parts companies were implicitly positioned to benefit from this tailwind, but the spoils were shared unequally. AutoZone moved swiftly to expand its suburban demographic through investments in employee training and in-store technology. The company increased its private-label brand inventory to 50% of its offering, appealing to customers looking for low-cost parts. It also expanded video resources for DIY mechanics. A key rival of AutoZone pursued a less aggressive response. As a result, AutoZone grew at a 50% higher rate than this direct competitor and beat their shareholder returns by ten points in the three years following the recession.

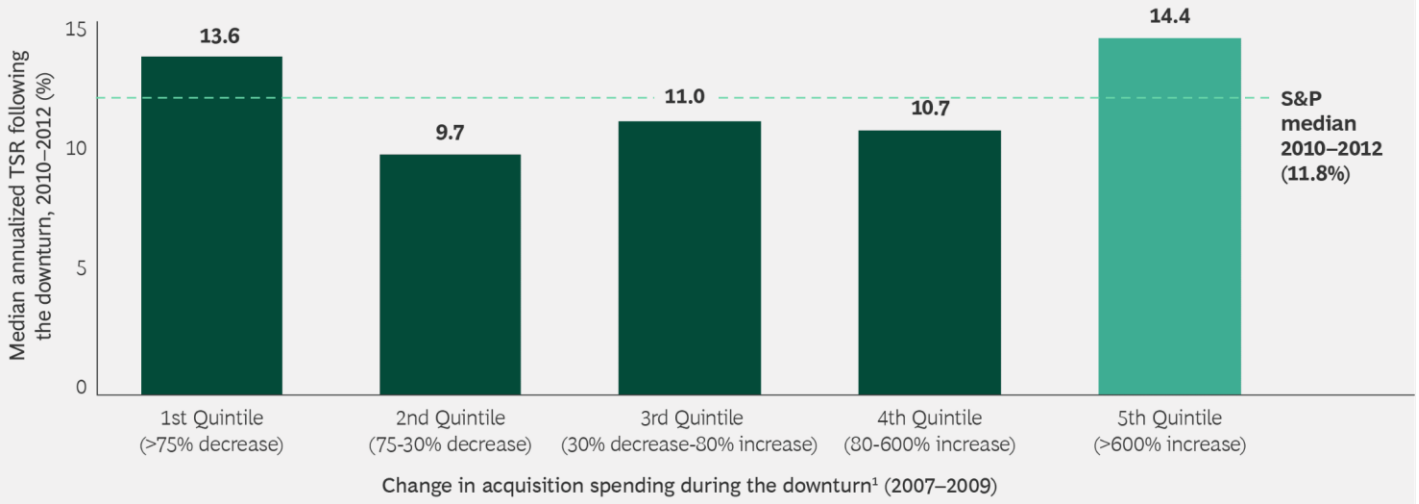
3. Accelerate restructurings or investments.
In normal times, major restructurings or investments, even when clearly advantageous, often stall in the face of tradeoffs and constraints. Revenue risk during transition, channel conflicts, or stakeholder inertia may delay action. A crisis, on the other hand, can lower barriers and opportunity costs, paving an easier path for action. Prior to the Great Recession, the US auto industry was faced with an inefficient and uncompetitive dealer network. While the "Big Three" automakers had long sought dealer consolidation, the recession and bailout opened a window of opportunity. Each manufacturer made sweeping moves. GM, for example, closed 40% of its 6,000 dealerships. Retained dealerships became larger, better managed, and more profitable as the industry experienced a decade of growth and margin improvement.

In the current pandemic lockdown, many valuable assets are idled, especially among retailers and businesses that are capital and fleet intensive. One countervailing benefit is the lowered cost of renovation and retrofitting. In this environment, companies can invest in value-boosting initiatives with a lower risk of sales forfeiture today than in the future—such as making stores attractive, lowering compliance risk, and enhancing production efficiencies. Stena Bulk, a European shipping company, recently announced that it is installing emissions scrubbers on 16 vessels to comply with newly tightened regulation. Scrubber investment is moving forward during a time of reduced shipping routes and staff.

Similarly, in the course of long-range planning, many companies contemplate attractive adjacent growth moves, only to sideline them in the shadow of a dominant core. Crises can shift this balance if the adjacency has better growth exposure once the crisis is over. In the last downturn, Aggreko, a mobile-power-generation company, saw a decline in the use of its equipment for events and construction. In response, the company swiftly shifted its focus from these applications to delivering emergency power generation in rapidly developing economies (RDEs), an on-trend shift aligned with RDE growth and the effects of climate change. These new geographic and application adjacencies increased sales from $1.2 billion to $1.8 billion in two years, and the company beat the S&P in value creation by nearly six-fold across the downturn.

4. Capture low asset values.
In a crisis, the world goes on sale. Exhibit 2 shows the extent to which companies leaning heavily into M&A from 2007 to 2009 outperformed the market.

Exhibit 2 | Companies that Significantly Increased M&A Spending During the Great Recession Saw Highest Total Shareholder Return



Sources: S&P Capital IQ; BCG analysis.
Notes: Data includes 194 companies listed in the S&P 500 in 2008. Data limited to companies with non-zero, dividend-adjusted stock price at the end of 2009 and 2012. Data excludes companies reporting zero acquisition spending in 2007 or 2009 and companies that decreased acquisition spending by >90%. Annualized TSR covers the period from the start of trading on January 1, 2010 to December 31, 2012.
[1] Acquisition spending is calculated as the maximum of cash spent on acquisitions or the total transaction value when available for deals.

PepsiCo had long seen strategic advantage in buying back a network of independent bottlers for reasons of quality, channel investment, and coordination. Early in the last recession, PepsiCo jumped at the opportunity, acquiring the weakened network at a discount after it had seen a $2.5 billion year-on-year decline in enterprise value. The $200 million of cost efficiencies enabled by the move better positioned PepsiCo to weather the rest of the downturn.

Similarly, Macquarie Group, an Australian investment bank specializing in infrastructure, entered the same downturn with a healthy cash position compared to its potential targets. In 2010, it saw the opportunity for adjacent US expansion through a favorable acquisition of Delaware Investments. This led to a string of serial moves, which culminated in Macquarie's transformation into a diversified investment bank and asset manager in a period when others retrenched. In this vein, companies should consider the full implications of M&A in the crisis of today.

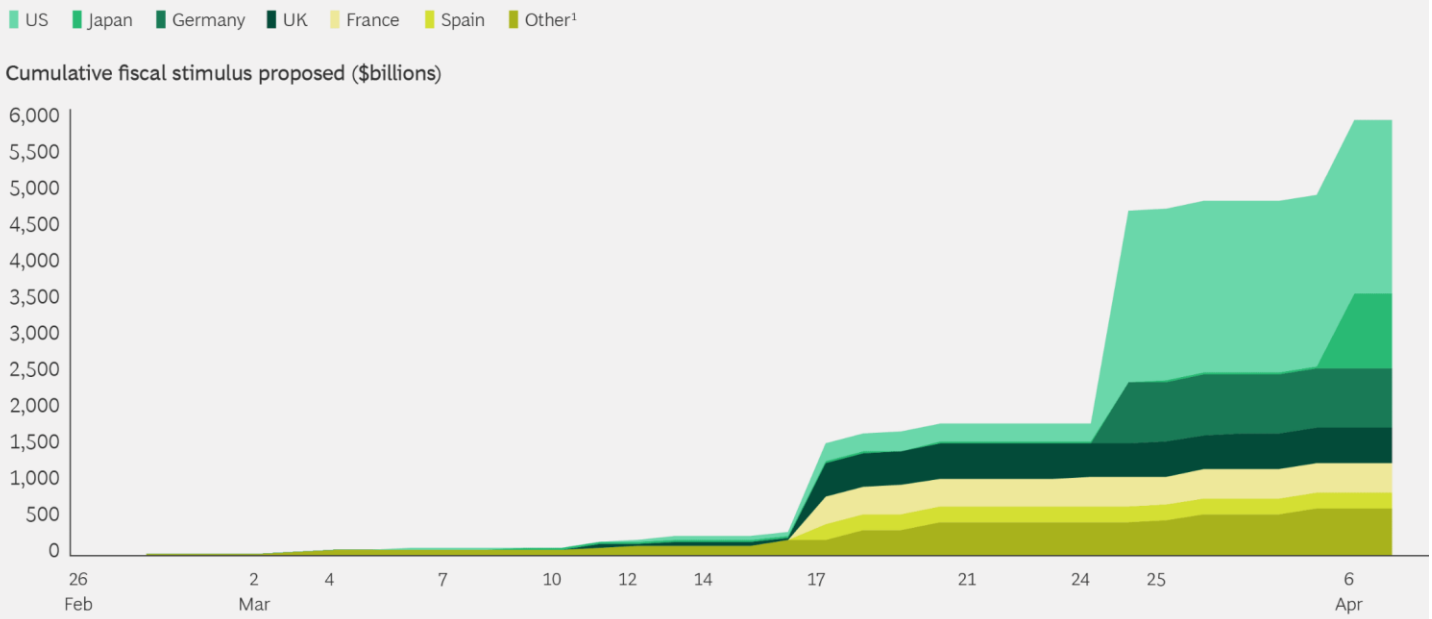
5. Build a government affairs capability.
As in prior crises, enormous stimulus packages and regulatory action are taking shape in response to COVID-19. Exhibit 3 shows how nearly $6 trillion in subsidies have been proposed across major markets thus far.

Meanwhile, regulatory regimes could unpredictably tighten or relax, from truck driver scheduling to food-labeling requirements. The likely magnitude, scope, and competitive impact of government influence argues for commensurate corporate engagement. Facing regulation or stimulus, companies must develop a firm ask from their government, as well as a credible narrative of how their actions are good for society, customers, employees, and the business itself. During the last recession, IBM advocated for relief under the American Recovery Act, helping to secure $30 billion for the technology sector. Following the act's passage, IBM launched a $2 billion kick-start fund, extending loans to eligible projects, including a new health care service that enabled data exchange between physicians and patients. By 2013, IBM had received $180 million in stimulus awards.

Additionally, board members, too, have a role to play. Thanks to their varied backgrounds and contacts, each can help shape the message, create advocacy, and engage policymakers. Following 9/11, a $12.5 billion rescue package for airlines failed in the US House of Representatives. Within a week, board members from the six main US airlines engaged directly with congressional leaders—Congress promptly approved $15 billion in airline support.

A century of company performance shows that, in the fog of crisis, longer-term opportunity is both abundant and obscured. Companies that penetrate the mist, that see and seize the chance for transformational moves and investment, can find advantage in the fog. When it clears, they will look around and find themselves in the lead.

Exhibit 3 | Global Stimulus Figures Climbed to Almost $6 Trillion by Early April 2020



Sources: Investopedia; government and news press releases; BCG analysis.
[1] 17 governments and international organizations have proposed a collective $630 billion in stimulus, including: Argentina, Australia, Brazil, Canada, Chile, Hong Kong, the IMF, India, Italy, Poland, Portugal, Russia, South Korea, Sweden, Switzerland, Turkey, and the World Bank.

By Matt Wicks

Automated storage and retrieval systems
To maximize DC productivity, automated storage and retrieval systems (AS/RS) are a connected material handling technology that dramatically increases inventory density while significantly reducing picker travel and item search times. Working in conjunction with warehouse management software, AS/RS support a variety of order fulfillment processes, such as: mixed-load, full-case and break-pack handling; product sequencing and buffering; route-based delivery sequencing; returns processing; kitting; and auto-replenishment of pick modules. Performance and inventory data from this automated material handling system can be further mined to enhance fulfillment productivity.

The most recent designs utilize shuttle-based storage and retrieval modules that travel throughout the cubic storage structure. Multiple shuttles are deployed to select totes of required items and deliver them to goods-to-operator stations. After the necessary items are pulled from the totes by either workers or robots, shuttles return each tote to its designated storage location. Additionally, the system continuously analyzes system density, automatically reshuffling storage locations and signaling for replenishment as needed to maximize inventory availability and throughput. The addition of more shuttles and storage modules as needed allows AS/RS technology to scale in alignment with consumer demands.

Order picking technologies
Deploying order picking technologies — such as pick-to-light modules that indicate the location and required quantity of a given item — generates substantial increases in order fulfillment accuracy and workforce productivity. Offered as a standalone or fully integrated, semi-automated material handling technology, tightly integrated pick-to-light hardware and software flexibly scale up (or down) to meet shifts in order volumes and seasonal peaks. These systems also deliver greater insights into worker performance by providing real-time monitoring and support smart batch picking, building pick assignments based on priority, and enabling one picker to fill several orders in a single path through the warehouse.

Voice-guided solutions
Mobile workers have a critical place in the DCs of today and tomorrow. Given the challenges of their duties and the rapidly escalating demands of order fulfillment, it's now more important than ever to empower these valued employees. Honeywell Voice does this and more by increasing productivity, improving accuracy, and promoting employee safety. With the adaptability to integrate into virtually any workflow process — including receiving, cross-docking, let-down and more — DC operators now are better equipped than ever before to meet the demands of their customer service level agreements. Based on rugged, ergonomic hardware and robust speech-recognition software, Honeywell Voice enables communication among workers, your warehouse management system and other business systems.

Robotic solutions
Today, DCs and the technologies that power them are changing faster than ever. Many operations struggle to keep up with the speed and complexity of modern e-commerce. Manual processes are still the norm in many DCs, even though the demand for workers is outstripping the available labor pool by a ratio of six to one.

Fortunately, the latest wave of automation has arrived. Honeywell Robotics takes on the burden of the most physically demanding and injury-prone jobs, moving workers into safer and more enjoyable positions. From picking and singulation to unloading and palletizing, our broad portfolio of robotic innovations is designed to improve

worker satisfaction, increase warehouse productivity, and ensure orders are fulfilled more rapidly and with greater accuracy than ever before.

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*These are just an overview of the types of warehouse automation solutions offered by Honeywell Intelligrated. Sponsored content by **Honeywell Robotics**.*

Researchers Assess Thermal Conductivity, Defect Density of Four GaN Varieties

Using advanced techniques, researchers more-accurately characterized the thermal conductivity of four distinct GaN substrate types along with their defect density, and developed a formula linking the two parameters.

By Bill Schweber

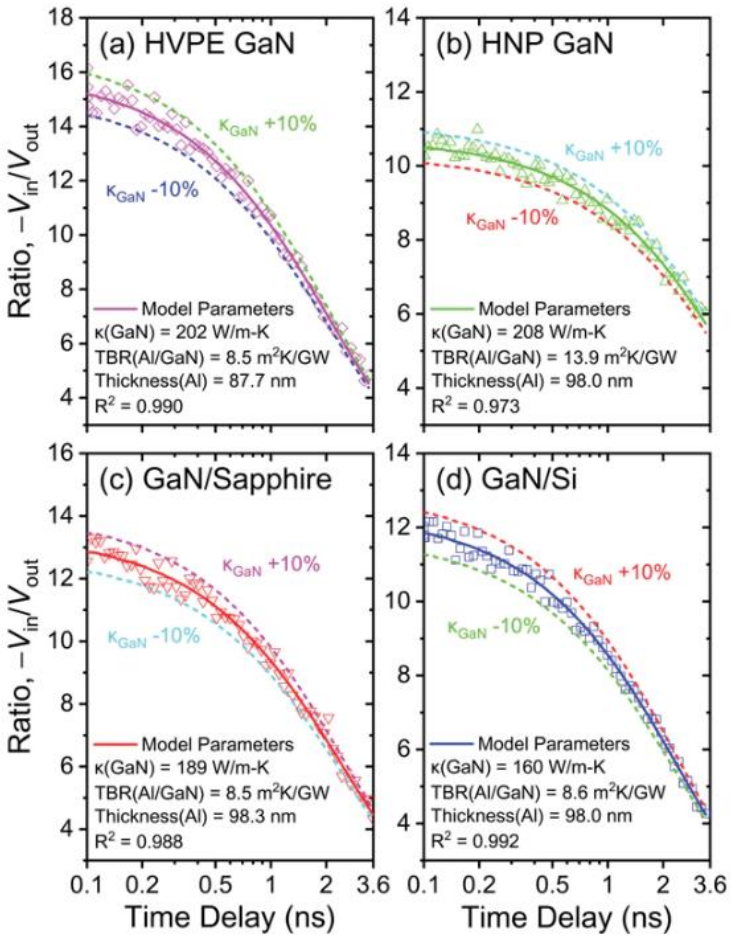
Semiconductors based on gallium-nitride (GaN) substrates are increasingly important in the power-device landscape. Their thermal conductivity, and thus their ability to conduct and so dissipate heat, is also a critical parameter.

A two-person team, based at the Nick Holonyak, Jr. Micro and Nanotechnology Laboratory at the University of Illinois at Urbana-Champaign, measured the thermal conductivity of four commonly used GaN substrate implementations along with other defining attributes. They noted that GaN thermal conductivity is reported to range from 110 to 269 W/m-K, which suggests a strong dependence not only on growth methods and conditions, but also measurement techniques and assumptions.

They noted that the standard thermal models as well as their relationship to dislocation densities may not be adequate given the different approaches (note that these dislocations adversely affect GaN-device performance). They anticipate that their new, presumably more-accurate model of the relationship between fabrication approach and the associated dislocation densities will lead to improved GaN process, thermal, and other models.

To do this, the researchers fabricated and tested four standard techniques used for fabricating c-plane GaN substrates, and measured their resultant thermal conductivity (κ_{GaN}) factors as follows:

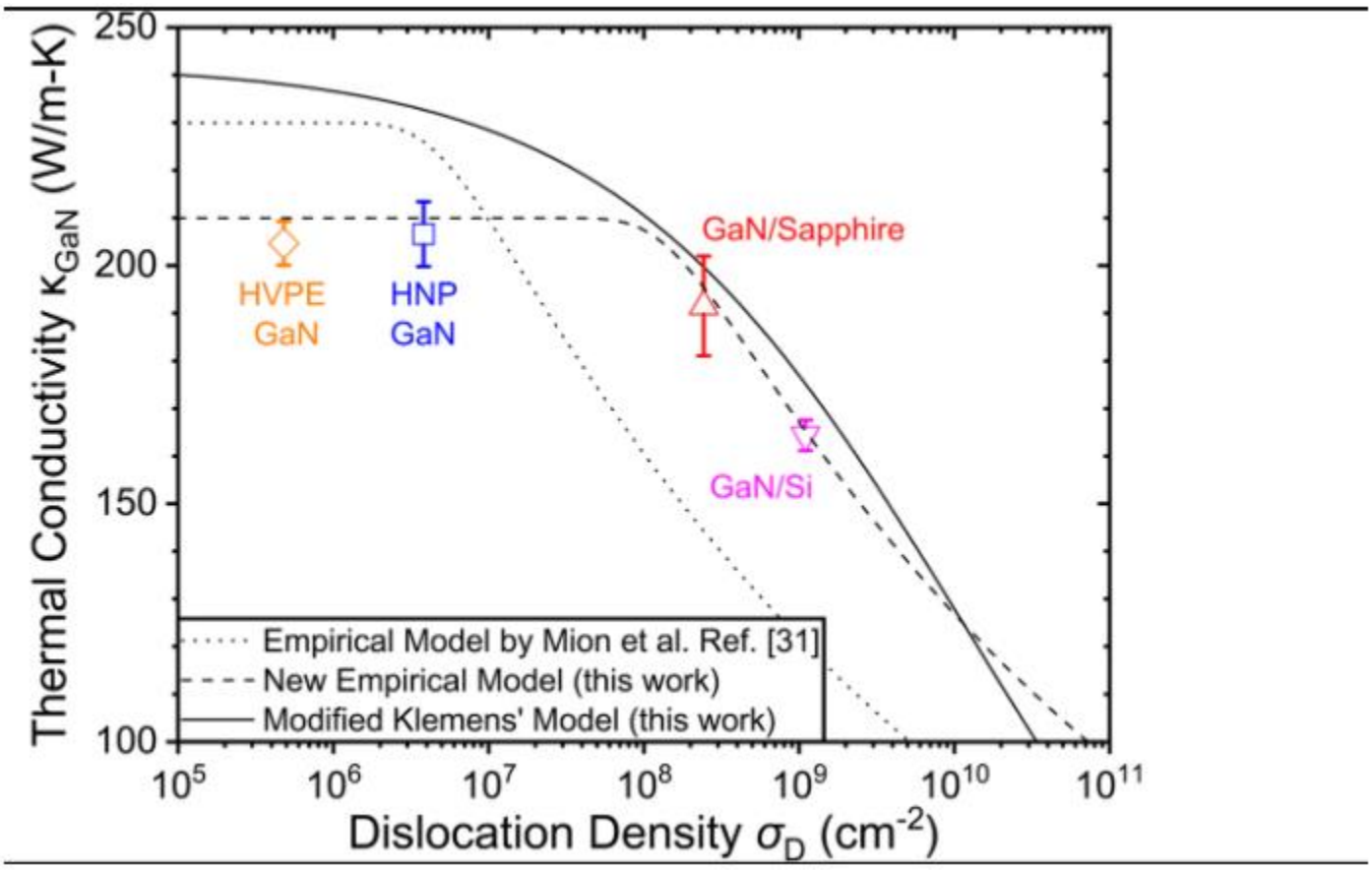
- 350-µm-thick freestanding GaN grown by hydride vapor phase epitaxy (HVPE): 204.7(±4.6) W/m-K
- 350-µm-thick freestanding GaN grown by high nitride pressure (HNP): 206.6 (±6.8) W/m-K
- 4.5-µm-thick GaN grown on the sapphire substrate by metal-organic chemical vapor phase deposition (MOCVD): 191.5 (±10.5) W/m-K;
- 5-µm-thick GaN grown on the Si(111) substrate by MOCVD with step-graded $Al_xGa_{1-x}N$, and AlN buffer layers in between: 164.4 (±3.2) W/m-K



To evaluate the thermal conductivity, they employed standard time-domain thermoreflectance (TDTR) techniques with a laser light source generating pulses at an 80-MHz repetition rate. These pulses were split into a pump beam and a probe beam, with the pump beam modulated by an electro-optical modulator using a

200-Hz chopper. A fast-response photodiode detector coupled with an RF lock-in amplifier was then used to pick up the reflected laser signal. The resulting graphs also show the time delay (in seconds) used to allow the thermal energy to propagate through the sample *(Fig. 1)*.

Their efforts didn't end with the measurement of thermal conductivity. In addition, they used sophisticated cathodoluminescence (CL) and X-ray diffraction techniques to evaluate crystal dislocation densities (σ_D) along with secondary ion mass spectroscopy to measure impurity concentration. Finally, they developed a complex empirical model equating the relationship between thermal conductivity and these dislocation densities, and believe it explains the experimentally observed rate of decrease in κ_{GaN} with increasing σ_D *(Fig. 2)*.



The team further believes their work shows that the thermal conductivity of a heteroepitaxially-grown GaN material can be estimated based on its dislocation densities, thus providing key design guidelines for thermal management in these semiconductor devices. The device-fabrication physics study, which was supported by the Air Force Office of Scientific Research (AFOSR), is published as "Impact of dislocations on the thermal conductivity of gallium nitride studied by time-domain thermoreflectance" in the *Journal of Applied Physics* from the American Institute of Physics, with additional Supplementary Online Material as well.

Despite Current Environment, Fintech Startups Continue To Hire And Raise Funds

By Christine Hall

COVID-19 is pushing companies to accelerate their innovations in a matter of weeks rather than years, such as accepting mobile payments or giving their brick-and-mortar store an online presence.

The financial services industry is one of the bright spots in an otherwise gloomy environment of record unemployment and layoffs at companies of all sizes. Despite the current economic climate, companies in the financial services space are not only continuing to hire, but are fundraising and being acquired.

"Consumers are more open to using financial technology applications and are more trusting," said Jillian Williams, principal at Anthemis Group. "Meanwhile, financial institutions are being forced to adopt technology because it is uncertain when social distancing is going to end."

In funding news, fintech companies are seeing more opportunity, she said. For example, in January, Visa acquired Plaid–a network that enables users to securely connect their financial accounts to apps they use to manage their financial lives–or $5.3 billion. Days later, Visa invested an undisclosed amount in Very Good Security, which helps fintech companies better protect their data.

Meanwhile, stock brokerage firm Robinhood announced in April it was looking to raise $250 million to improve the app's infrastructure.

'Stamp of approval'
Financial technology became popular following the economic downturn in 2007 and 2008, when new companies launched products with the claim they could better serve customers than banks, Williams said.

Back in 2010, companies in that sector represented 10 percent of total venture funding, according to Crunchbase research. In 2019, it was 16 percent with $43 billion invested.

Recently, companies in the sector received "a stamp of approval" from governments due to the recent U.S. Small Business Administration's Paycheck Protection Program, she said. Banks, along with financial technology firms, such as mobile payment company Square Capital, could make loans, while people could receive their stimulus check funds via Venmo, she added.

Flush with cash and hiring
Even as companies lay off workers, financial services firms continue to hire. Data from HackerRank shows that interviews at financial services firms are up 39 percent since Jan. 1 among clients such as Goldman Sachs, PayPal and Morgan Stanley.

"There is massive acceleration to become a tech-first company," said Vivek Ravisankar, co-founder and CEO of developer hiring firm HackerRank. "Heinz announced it will be selling direct-to-consumer. It is now easy to order via apps like Shopify. You are able to transfer money from one bank to another. We are seeing tech, fintech and retail, in terms of developers, starting to grow more because everyone wants to have an e-commerce presence. It is both frightening and exciting."

Ravisankar said he credits those figures to another big shift: Companies are getting comfortable with remote hiring. Opening up the talent pool makes it grow larger by 10 times, he said.

"Now you can hire developers anywhere as long as they are talented," he added. "That is a massive change."

Despite headlines to the contrary, hiring is still happening at startups, especially among those who have been able to raise funding.

San Francisco-based Fast, which is building a one-click login and checkout platform to help rid the internet of passwords, plans to hire some 60 people to join its 23-person staff by the end of the year, Domm Holland, co-founder and CEO told Crunchbase News.

Driving Fast's goals are not just demand, but also a $20 million Series A funding round the company closed in March. It was led by digital payment service firm Stripe, which itself announced a $600 million Series G extension a few weeks later.

"Where every sector is contracting, there is a credit crunch, people are losing jobs and companies are not actively hiring, we are uniquely growing and hiring," Holland said. "We are very hungry for talent."

The company is pre-revenue, but its login product is live on hundreds of websites, he said. Not surprising in this environment, one of his fast-growing customers is grocery chains. That sector of Fast's business has grown 15 times since the COVID-19 pandemic began.

"There is a whole wave of people who have to now order groceries online and, for lots of them, that is another password to learn," Holland said. "It's not just grocery, but true of enterprise, in general. We are in a unique position because we can move the needle and move at a blistering pace."

Tapping into the talent pool

As financial services firms look for their next employees, organizations such as New York-based Flatiron School are ensuring there is a pool of talent out there for them to find.

Flatiron School offers online and on-campus software engineering and data science courses across eight locations in the United States.

Its head of career services, Gretchen Jacobi, said technology has disrupted the financial industry. Now with social distancing due to the COVID-19 pandemic, every experience is disrupted.

Flatiron continues to evaluate which businesses are going to be resilient, which will see an increase in demand and which are hiring, as well as which businesses are freezing their hiring, said Jacobi. In addition, some companies that had offered jobs to graduates, rescinded them when the pandemic hit.

Many students come to the school to learn new skills so they can change careers, Jacobi said, adding that students who have a financial background, such as technology, accounting or marketing, have had success being hired.

"This shift is requiring consumers to go online to consume content, engage in an experience or buy something," she said. "Brick-and-mortar is out, and small retailers are popping up with an e-commerce storefront where they didn't have it. We are seeing a lot of activity needing to be supportive on the fintech side. There needs to be fraud protection and advanced payment processing. Fintech can find the tailwind, and we are seeing examples of students accepting jobs at this time in areas such as payment review."