

5

TECHNOLOGY TRENDS TO WATCH

A SPECIAL SUPPLEMENT TO



Consumer
Technology
Association™



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TRANSFORMATIVE TECH

Tech innovation is making the nation more resilient in the face of crises. The pandemic has bolstered the relationship consumers have with technology. From working to learning, staying connected with family, friends and colleagues, and taking care of our health, tech is playing a crucial role in improving lives. Even though the U.S. is confronted with supply chain shortages, labor gaps and spiraling inflation, tech will help us keep pushing forward.

As technology continues to transform industries and businesses, consumers' lives are enriched with enhanced safety, efficiency and an expanding array of choices. And it is entrepreneurs with an innovative mindset that are driving this new surge of technology, products, services and apps.

Retail sales revenues for the tech industry are soaring to a record-breaking \$487 billion in 2021 – a 7.5% jump year-over-year. This innovation is driven by extraordinary consumer demand for tech related to work, school and lifestyle, according to the twice-yearly [U.S. Consumer Technology One-Year Industry Forecast](#) produced by the [Consumer Technology Association \(CTA\)](#)®.

To provide context on the transformation taking place, CTA produces *Five Technology Trends to Watch* each year. CTA analysts select five top trends to explore how these areas could impact the industry going forward and the opportunities ahead. For the 2022 edition, the focus is on FinTech, Cybersecurity, the Future of Transportation, Food Tech and Digital Therapeutics to see how these areas are reshaping the way we live.

As the global stage for innovation, [CES® 2022](#), owned and produced by CTA, will take place in-person and digitally Jan. 5-8. If those who

attend CES in Las Vegas, along with all-access registrants, can watch keynotes, conference programming and exhibitor activations in the digital venue through Jan. 31, 2022.

CES is the best place to see the technologies on the horizon. Stop by the CES Innovation Awards showcase that recognizes the technologies of the future and Eureka Park where startups introduce their ideas and business models to the world. Come learn about amazing advances in health monitoring, robotics, virtual reality, machine learning, self-driving and electric vehicles, drone deliveries, and facial and voice-based security. New technologies are solving real problems and making the world brighter for global citizens.

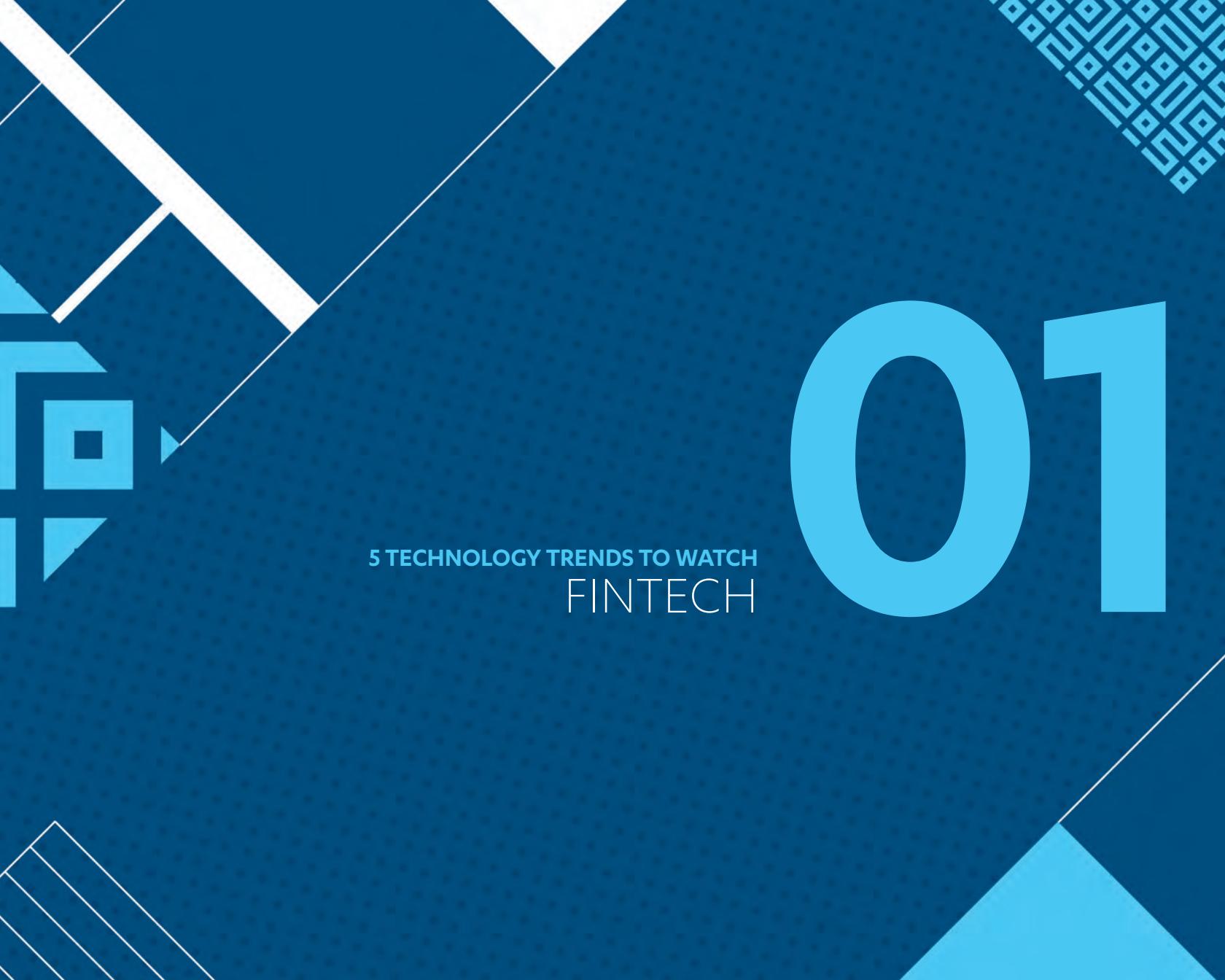
Come see the potential of technology to connect the world and empower each of us. For the most up-to-date information, visit [CES.tech](#).



A handwritten signature in black ink that reads "Gary Shapiro". The signature is fluid and cursive, written over a white background.

GARY SHAPIRO
CTA President and CEO





5 TECHNOLOGY TRENDS TO WATCH
FINTECH

01

01

FINTECH WILL REVOLUTIONIZE MONEY MANAGEMENT, AND PERHAPS MONEY ITSELF

BY DAVE WILSON

Fintech will transform finance in the coming years, presenting great opportunities for innovators able to help us manage our finances more easily and less expensively. Moving money costs money, and the cost varies depending on the method. We see this every day at gas stations, for example, where gas might cost one price if the customer pays with credit, and another price if payment is made in cash. The credit card transaction costs the station more, so it charges more to recoup its higher cost. What if there were a way to have the convenience of credit without the extra expense? This is the potential of today's fintech.

According to a 2015 report from the Association for Financial Professionals, the median cost to a business for sending and receiving paper checks was \$3.00 and \$1.57, respectively. On the other hand, the median cost for sending or receiving an automated clearing house (ACH) transaction was \$0.56. While the ACH method offers significant cost savings, it usually still includes monthly bank or payment provider fees, ACH fees and other costs. Imagine if those costs could be substantially reduced. Today's fintech solutions have the potential to do this.

Fintech solutions are not just about saving money. They can make life easier for the “unbanked,” those people who don’t have bank accounts. Innovations like PayPal’s Venmo have already made this possible by allowing people to receive, store and spend money with an app on their phone – no bank account required. But payment systems like this have fee structures similar to credit cards. For example, Venmo charges merchants 1.9% + \$0.10 when a customer pays with Venmo. While the app is innovative and clearly a hit with consumers, fee-wise this system is not much different than the plastic card payment systems in use for decades.

New fintech innovations promise to disrupt legacy systems and business models. The principal innovation showing this promise is blockchain, which could allow us to send and receive money without the legacy financial systems we have used for years.

Traditionally, the movement of money has involved trusted third parties who often profit when money changes hands. However, blockchains now make it possible for two parties to do business without a trusted third party. The blockchain, itself, is trustworthy and it enables new business models where money moves for free. Forward-looking companies are already developing blockchain-based payment systems, each hoping it will be the one consumers quickly adopt. With payment systems as with social media, the bigger a network gets the more value it has to users, and the more people want to use it, so it grows even larger. It is a virtuous cycle.

Blockchain

Blockchain designs are not all the same, but they have similar characteristics. Blockchains are ledgers containing every transaction made “on the chain.” The bitcoin ledger is public, everyone can see every transaction but not every detail of every transaction. The bitcoin ledger is viewable at blockchain.com/explorer. It’s the

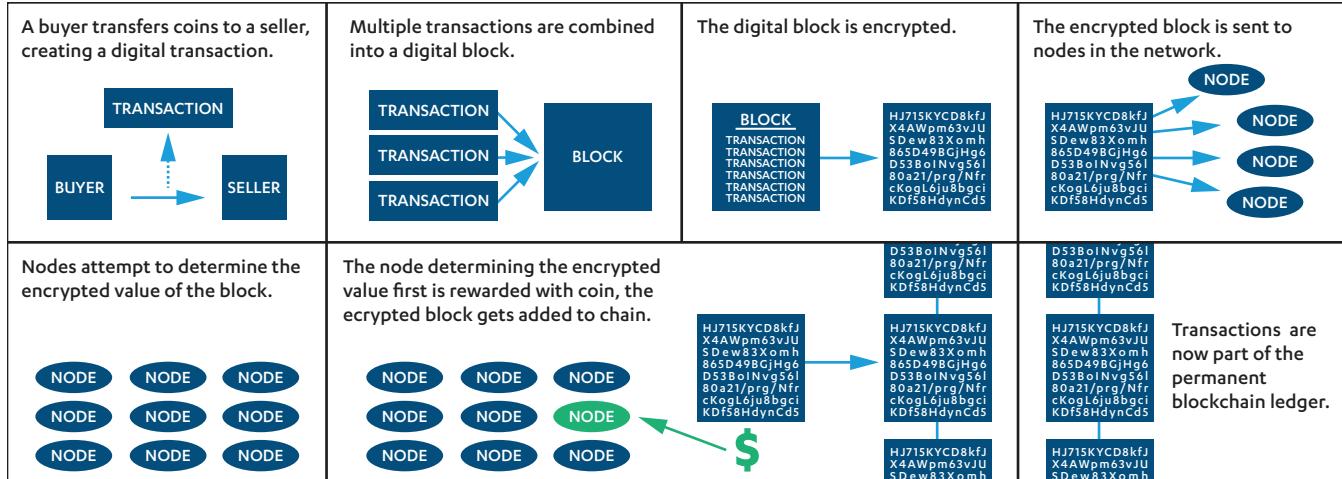
public nature of the bitcoin ledger that helps make it secure. The numerous copies of the ledger all over the world all act as backup copies. If one instance of the ledger gets corrupted or someone tries to tamper with it, the existence of numerous other copies around the world helps to establish reality.

FINTECH SOLUTIONS ARE NOT JUST ABOUT SAVING MONEY. THEY CAN MAKE LIFE EASIER FOR THE “UNBANKED.”

That is not to say blockchain ledgers are magically immune to attacks, but the concept of distributed ledgers has been tested for decades under real world conditions, so there is reason to be confident in society’s ability to make them work. Evidence to support this comes from a building block of the internet, itself. Distributed throughout the internet are dynamic name servers, which are essentially ledgers that associate human-friendly names like CTA.tech with computer-friendly numeric addresses like 40.71.11.131. This system has been running for about four decades and, despite attempts by hackers to corrupt it, has continued to accurately send us to the websites we ask for. Since a trustworthy DNS system was achievable, it seems trustworthy blockchain systems should be achievable, too.

While the bitcoin ledger is public, information about the entities transacting business with bitcoin is not. When coins are sent from one account to another the network encrypts the transaction. The transaction is not executed until one of the network’s millions of computers verifies its validity. This verification process involves guessing the encrypted code associated with the transaction – not solving the encryption, but guessing what the transaction looks like *after* it has been encrypted. If a computer on the network is able to do this, then the transaction is validated and gets added to the blockchain. The owner of the computer that validates a transaction

Blockchain Basics – How a Blockchain like Bitcoin Works



Source: CTA

is rewarded with bitcoin. People that validate bitcoin transactions and receive bitcoin in return are called miners.

Bitcoin is one of many blockchain applications, and not all blockchain ledgers are public. China's Blockchain Service Network (BSN) is one of the first blockchain networks created by a central government. It requires all users to go through an identification and verification process, so the identities of everyone using the network are known to the network operators at all times. Network operators have the ability to review transactions on the BSN and block them by using the BSN operator's key. The BSN can be used for executing different types of transactions but it does not include a cryptocurrency. Instead, China appears poised to use the BSN to improve the efficiency of transactions made over existing banking

networks using the new digital version of its traditional currency, the yuan.

This summer, the official website of the Chinese province of Xiong'an reported that the People's Bank of China completed the country's first salary payments using the BSN after engineering subcontractors made payments directly to employees' digital wallets from a public wallet and recorded the relevant data on a blockchain. The employer put the employee's digital wallet ID, payment amount and other salary information on the BSN and the bank then deposited digital yuan into the employee's account in accordance with the amount indicated on the blockchain. It was not a direct exchange of cryptocurrency, but rather a blockchain-directed exchange of the digital form of traditional Chinese currency.

China's work is noteworthy because it offers insight into where the government of a leading world economy may be headed when it comes to blockchains and financial transactions. By itself, using blockchain to pay wages is not that newsworthy.

BitPay, an Atlanta-based cryptocurrency services provider, has been helping companies pay employees in cryptocurrency for about a year. When launching BitPay Send last year, CEO, Stephen Pair commented, "Blockchain payment adoption is growing because it offers an easy way to send and receive payments on a global scale. Traditional international payment methods are cumbersome, costly and slow. With BitPay Send, companies can make mass payouts without having to buy, own or manage crypto and their recipients receive payments quicker and at a lower cost."

Maybe Not a Criminal Hideout

Bitcoin and, by extension, cryptocurrencies generally, have a reputation as a technology criminals like to use to hide their illegal activity. This reputation is enhanced when high profile criminal acts, like the ransomware attack on the Colonial Pipeline on the U.S. East Coast in May, 2021, are accompanied by demands from hackers that extortion be paid in bitcoin. In reality, a cryptocurrency like bitcoin is not a good tool for criminal activity because every transaction is recorded permanently, and stored on numerous copies of the system ledger all over the world.

Although it might not be immediately obvious who is behind a bitcoin transaction, government authorities with the power of subpoena can often piece it together. In the Colonial Pipeline case the U.S. Department of Justice quickly recovered most of the ransom a month after it was paid. The government said by reviewing the bitcoin public ledger it was able to track multiple transfers of bitcoin and identify that roughly 63.7 bitcoins, representing most of the roughly 75 bitcoin ransom payment, had been transferred to a

specific address for which the Federal Bureau of Investigation (FBI) had the "private key," essentially the password needed to access the coins. Bitcoin is not a great way to hide ill-gotten gains.

Bitcoin is a Work of Art

Some consider bitcoin "digital gold" because the supply of bitcoin is limited, just like the supply of gold on the planet. However, gold has utility beyond its use for storing wealth. It's used mostly to make jewelry, but it is also used in electronics, dentistry, medicine and more. Bitcoin has no utility beyond its use for storing wealth, except perhaps as a source of satisfaction for those who enjoy owning something so innovative. In that respect, Bitcoin is more like art than gold. The supply of original Van Gogh paintings is limited, just like the supplies of gold and bitcoin.

Neither a Van Gogh nor a bitcoin have much utility beyond bringing satisfaction to people. Satisfaction is important, for sure, but if that is all they do then they are only valuable as long as others appreciate them. If people lose interest and find satisfaction elsewhere, they could become worthless. That is not as likely with gold because it is used to make things.

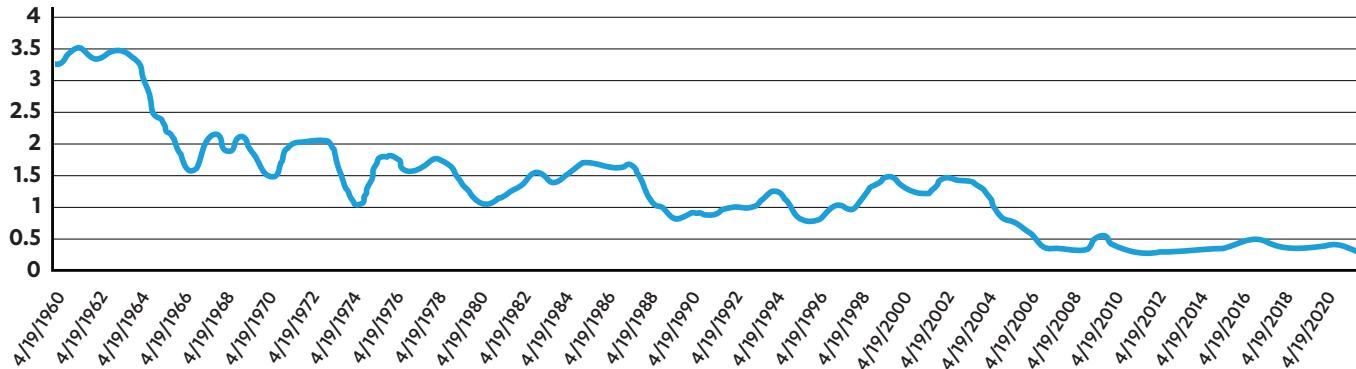
Bitcoin as Currency

Some, like those who want the U.S. dollar (USD) back on the gold standard, are intrigued by the possibility of bitcoin replacing fiat currency. It is hard to imagine any government letting that happen. Politicians want voters to reelect them, and they seem to believe this requires that government give more to voters than it takes. This results in an accumulating mountain of debt. If we were on the gold standard – or "the bitcoin standard" – the government's ability to accumulate debt would be limited because the supply of money would be limited. Money supply, inflation and government debt are major topics on their own. Let's just say we shouldn't expect a limited supply cryptocurrency

El Salvador Makes Bitcoin Legal Tender

It says its value “answers exclusively to free-market criteria” unlike USD

— Pounds of copper that could be purchased with \$1



SOURCE: [Macrotrends.net](https://www.macrotrends.net)

(data converted to pounds of copper per dollar and smoothed using trailing 200 day moving average)

like bitcoin to become the single official currency of a nation anytime soon.

An alternative official currency is another matter. Earlier this year El Salvador became the first country in the world to formally adopt a cryptocurrency (bitcoin) as legal tender. For the past 20 years El Salvador’s official currency has been the USD, and even now that bitcoin has become legal tender, the USD will still be used “as the reference currency” for “accounting purposes.” However, what happens in El Salvador is worth watching.

Fedcoin is a Work in Progress

For its part, the U.S. Government is moving at a measured pace on digital money. The Federal Reserve is exploring the concept of a

central bank digital currency (CBDC) and plans to release a research paper on the topic this fall. Some Fed officials have recently expressed skepticism about the need for a CBDC. To learn what the Fed as a whole thinks, we will have to wait and see.

Stablecoins

A stablecoin is a cryptocurrency coin that can be exchanged for a specific amount of government-issued currency. For example, Circle offers products that allow people to trade using USD Coin (USDC), a cryptocurrency stablecoin that can be exchanged one-for-one for USD. Unlike bitcoin and other cryptocurrencies that are not stablecoins, there is no risk to users that the dollar value of their cryptocurrency will change over time, though there is risk that the USD, itself, will decline in value over time. USDC

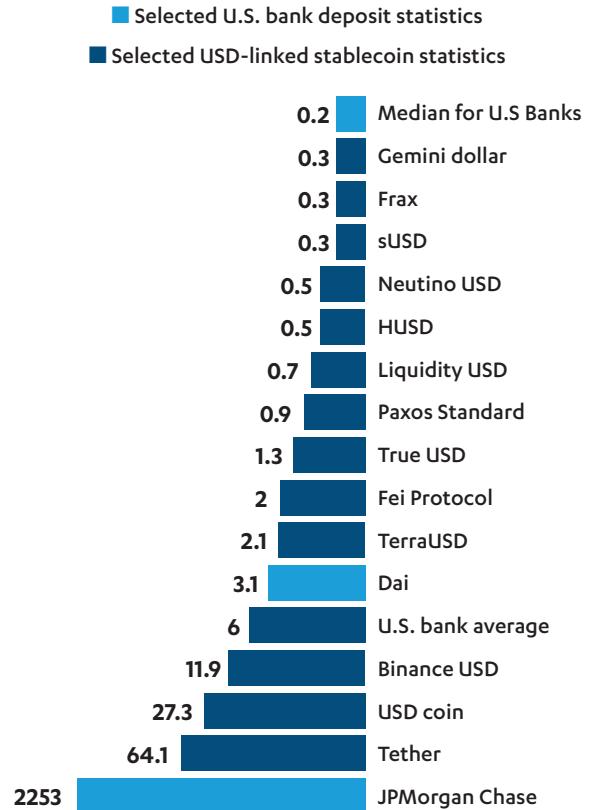
is issued by regulated financial institutions and backed by fully reserved assets, meaning the issuers keep sufficient USD on hand to fulfill USDC redemption requests. USDC is governed by the Centre Consortium, a membership-based consortium that sets technical, policy and financial standards for stablecoins. As of August 2021 there were \$27.3 billion worth of USDC in circulation, and all-time total transactions on the USDC blockchain totaled \$1 trillion.

While there may be little or no risk that the dollar value of a stablecoin will change over time, there are other risks. Tether is another popular USD-linked stablecoin. Earlier this year it and Bitfinex, which are owned and operated by a small group of executives and shareholders located around the world, agreed to pay an \$18.5 million penalty to the State of New York after an investigation found the companies failed to alert the public when hundreds of millions of dollars kept on account to back their stablecoins appeared to become unavailable when the third-party institution holding the USD reserves failed to honor requests for redemptions. This illustrates the importance of not only being able to trust the blockchain, but also being able to trust the institutions backing stablecoin cryptocurrencies with fiat currencies.

BLOCKCHAINS NOW MAKE IT POSSIBLE FOR TWO PARTIES TO DO BUSINESS WITHOUT A TRUSTED THIRD PARTY.

Facebook-backed Diem (formerly known as Libra) tried to establish a global stablecoin tied to a basket of major currencies and debt, but switched focus to multiple stablecoins, each backed one-to-one by different country currencies in an effort to win government approvals. Global policymakers remained skeptical, and in May 2021 Diem announced the withdrawal of its application

U.S. Bank Deposits and USD-linked Stablecoin Market Caps USD (Billions)



Source: [2021 stablecoin data](#)

Source: [2021 bank deposit data](#)

Processing Speeds of Some Fintech Systems

Technology	Maximum Transactions per second	Avg. settlement time per transaction
VISA network	6532 avg. for year ended 6/30/21	1 day for check card transactions
EOS blockchain	2800	0.5 sec.
Ripple blockchain	1500	3-5 sec.
NEO blockchain	1000	15 sec.
Ethereum blockchain	20	5 min
Bitcoin blockchain	7	10 min.

NOTE: The VISA network data is an average calculated from reported annual transactions for the year ending 6/30/21. The actual number of transactions per second throughout the year would not be constant, so the maximum transactions per second in the year would be higher than 6,532.

SOURCES: <https://bit.ly/3n5EeeR>, <https://vi.sa/3Cbqqs2>, <https://vi.sa/3G481gq>

for a payment system license from the Swiss Financial Market Supervisory Authority (FINMA), the move of its headquarters from Geneva, Switzerland to Washington, D.C., and a partnership with Silvergate Bank to issue a USD stablecoin. Facebook is still active in the Diem Association and plans to launch Novi, a digital wallet for Diem. Novi will let people send and receive money as easily as they message friends, family and businesses.

Non-fungible tokens (NFTs)

Coins representing money are not the only things transferred between parties on a blockchain network. Anything digital can be transferred and one such thing capturing much attention is the NFT.

A simple way to understand NFTs is to think of your bank statement. It's a ledger that shows the transfers into and out of your account over the past month. Each transaction shows a certain number

of dollars, but it does not show specifically which dollars were transferred. That is, the serial numbers of individual dollars are not tracked, only the number of dollars transferred. This is how bitcoin and other cryptocurrencies work, too. Only the number of coins transferred is recorded on the blockchain ledger. The coins, themselves, do not have serial numbers.

NFTs are specifically identifiable. When an NFT is transferred from one party to another the identity of that specific NFT is tracked. If your bank did something like this with your money, it would be tracking the serial numbers of the specific dollar bills moving into and out of your account. So, when an NFT is transferred from one party to another, the identity of that specific digital item is tracked along with its ownership information. An NFT could be a picture, a song, a video, or anything else that can be digitized.

It is easy to imagine uses for NFTs beyond collectibles. For example, records documenting the transfer of real estate could be stored on a blockchain as NFTs. So, too, could automobile ownership records. In fact, anything that requires a record of ownership transfers of a specific digital asset could be a good application of NFT technology.

Decentralized Finance (DeFi)

DeFi refers to cutting out the middlemen in financial transactions. Paper money can facilitate DeFi. If people trading with one another all agree to pay only with paper money, and they all keep their money at home, that's DeFi. There are no banks, brokerages or similar institutions involved.

Transacting in cash can be problematic because storing paper money requires security measures to combat the threat of theft or potential loss from fire, flood, etc. Blockchain technology addresses these problems, making it possible for people to easily transfer money to one another without a bank or brokerage.

Using a blockchain network it is possible for people to have digital wallets full of cryptocurrency on their smartphones. They can move money between accounts without ever dealing with a bank. Obviously, this is a threat to the banking industry. Blockchain-based DeFi is also a concern for governments because banks and brokerages help governments ensure taxes are collected, and help governments catch people running criminal enterprises. This is accomplished by requiring banks and brokerages to report certain transactions to the government, and to comply with “know your customer” rules.



Banks and brokerages must establish each customer’s identity, understand the nature of the customer’s activities, and assess money laundering risks associated with each customer. In a truly DeFi blockchain network, no one is checking on the identity of account owners, though a public blockchain network like bitcoin can have other advantages for governments, since all transactions are visible to the public with no search warrant required. As blockchain and cryptocurrency systems evolve it is safe to assume lawmakers and

regulators will look to update regulations so the government can continue to achieve its objectives.

Blockchain-based DeFi networks can have advantages over legacy systems for consumers, too. This is especially true for people without bank accounts (the “unbanked”), who have a new way to give and receive money without the challenges of always dealing in cash. Also, for people with bank accounts who spend a lot of money on transaction fees and do not receive much interest income, using fee-free electronic transactions with stablecoins could be a money saver.

Where is all this Headed?

Recent decades have seen widespread adoption of free communication methods (email, messaging, etc.) where companies providing these free services developed business models allowing them to generate income from other aspects of their relationships with the people using the free email services. The next couple of decades are bound to see something similar happen with the movement of money.

China seems headed toward a blockchain that directs the movement of money through existing banking channels. The U.S. seems inclined to allow private development of various stablecoins linked to the USD. Both have major implications. Other countries are looking at blockchain applications, too, with El Salvador being first to adopt bitcoin as legal tender.

In China, it is possible the government will eventually have visibility into every single financial transaction. In the U.S it is possible that payment networks that make money from transaction fees could be replaced by stablecoin networks that make money from interest on the USD held in reserve. Lawmakers and regulators around the world will continue studying new fintech technologies in the coming years and developing new rules for their use. Fintech is an important technology to watch. ■



5 TECHNOLOGY TRENDS TO WATCH
CYBERSECURITY

02

02

A VERY PANDEMIC CYBER WORLD

BY MIKE BERGMAN

After the events of 2020, it was reasonable to enter 2021 with some hope of a better year. In cybersecurity, this was not the case. Attacks on PayPal, American Express, Microsoft Exchange, Colonial Pipeline and SolarWinds, were some of the major incidents that have occurred since January 1st of 2021. Consumers were hit as well. Overall, groups that track threats report growing activity, more attacks and increased destructive impact.

Three major challenges for 2022 involve data theft, ransomware and denial of service attacks. Money is the root of all evil activity in cyberspace, and the rise of digital currencies like bitcoin has made it possible to make payments and transfers anonymously. While enterprise attacks are on the rise, consumers are also increasingly victimized by these attacks.

However, the picture isn't entirely bleak, and after looking at the threat side of the coin, this article will also look at various options for consumers, such as protection strategies and even how to adjust one's investment strategy.



The Shutdown Was Not Fun

It's not a coincidence that cyberattacks are up since the pandemic began. Prior to the shutdown, attacks had already been rising. But during the shutdown itself, that rise accelerated. The world's workforce suddenly found itself locked out of the office and more vulnerable, even as attackers were refining and extending their methods.

Video conferencing immediately became a way of life. Imagine if a product suddenly acquired dozens of times more users, massive media coverage, and very close attention from security researchers and hackers. That's exactly what happened to Zoom. In the media spotlight daily, in five months Zoom went from 10 million daily meeting participants to 300 million. Perhaps the most significant challenge was that the high use and detailed attention revealed security issues that had previously gone unnoticed. But Zoom stepped up, with a security upgrade in September 2020.

Corporate network managers were also hit with multiple challenges. The pivot to an all-virtual workforce pushed significant change on IT departments in a very short time, a recipe for potential issues. The entire workforce suddenly needed access to network resources from home. Corporate IT had to extend virtually to home networks and devices, requiring IT managers to consider new threats and mitigations. Video conferencing, collaboration tools, authentication tools, virtual private networks (VPNs) and remote management software all needed a fresh look due to much higher usage. With the increased activity from hackers and the increased attention on major breaches, it became clear how important software, device driver and firmware updates were for both uptime and security.

IT departments were working overtime to enable our remote national workforce. Something had to give. Verizon's [Mobile Security Index 2021](#) found that 45% of respondents said that their

companies had sacrificed mobile security to just "get the job done." In the same survey, 48% of those who made some kind of sacrifice on cybersecurity said that one of the reasons was dealing with the COVID-19 crisis. These numbers illustrate how much pandemic-related changes in the nature of work have led to increased vulnerability for companies and their employees.

About the SolarWinds Breach, "SUNBURST"

SUNBURST is the name given to a "backdoor" at the center of the infamous breach of SolarWinds first discovered in late 2020. SolarWinds produces network management software called Orion, which monitors network performance and applications on enterprise networks. The attackers somehow got into the SolarWinds "build" servers – computers used by SolarWinds to host the source code and build the Orion final product. A first successful attack into the SolarWinds enterprise network allowed the attackers to insert backdoors into updates of Orion. Companies that installed the software updates unknowingly gave the hackers entry to their networks. Over 18,000 companies were potentially affected, although it is believed the attackers only accessed a small number of these companies.



A Post-Pandemic World of Attacks

The main concerns today are about data theft, ransomware and denial of service attacks.

Security folks refer to a data breach or data theft as “data exfiltration”: “theft or unauthorized removal or movement of any data from a device.” Security of enterprise systems has gotten better over the years, but hackers can take a small opening and exploit it to get a little more access, and then from there a little more, and so on to the full breach.

Data theft was one of the first goals of hackers (along with theft of services, such as long-distance phone calls). Over time, hackers have become more ambitious. In 2013, Target was the subject of a data breach that the company announced could impact tens of millions of customers. It was the largest breach of its kind at the time, but Target is by no means the only major retailer or business that has had data stolen, and since that time LinkedIn, Facebook,

Yahoo!, Starwood (Marriott), Twitter, Experian, Equifax and others have been victimized at large scale.

The SolarWinds exploit was just such a situation. Hackers sponsored by the Russian Foreign Intelligence Service (SVR) tapped into software that was used by many enterprises and federal agencies in the U.S. By attacking a supplier to companies rather than the companies themselves, the attackers were able to multiply the reach of the attack many times. When this sort of upstream attack occurs, it’s referred to as a supply chain attack.

Ransomware is another major threat in 2022. Like data exfiltration, ransomware starts with hackers gaining access to enterprise (or even consumer) systems. Once “in”, the malware will encrypt the system’s hard disk drives. Typically an email or pop-up tells the user that their system is encrypted and demands payment, usually in bitcoin. The U.S. Federal Bureau of Investigation (FBI) discourages paying up. It notes, “Paying a ransom doesn’t guarantee you or your organization will get any data back. It also encourages perpetrators to target more victims and offers an incentive for others to get involved in this type of illegal activity.” Ransom payments tend to fuel illegal activities and prop up dictatorships. In the latter case North Korea’s military has been accused of ransomware attacks to finance the sanctioned regime.

Like a biological virus, ransomware is evolving. The first and most obvious trick the criminals learned was to stay inside the infected system, even after payment. That way they can continue to sift through corporate databases or shut systems down again for another payment.

Possibly the most innovative new technique is for ransomware operators to offer payment to employees to load the malware

themselves. This is the equivalent of a warring feudal lord bribing a guard to open the gates of the fortress.

The third major concern is the “distributed denial of service attack”, or DDoS. To “deny service” on the internet, a massive flood of useless traffic is sent to confound the hapless webserver or other internet system. Overloaded with inbound rubbish, the internet system cannot support legitimate requests, like showing a favorite web page.

Today these attacks are done with a slew of devices worldwide, devices that have been hacked for this purpose. The “distributed” nature of the attack turns the small-scale technique into a DDoS. Hackers used to compromise individual computers in order to use them for the source of such traffic. But now the internet of things (IoT) is also a source of computing power for these DDoS attacks, since many IoT devices are built with a small but powerful computing platform and an operating system such as Linux.

DDoS attacks are on the rise. Already a problem in 2019, DDoS defense specialty company CloudFlare observed for 2020, “After doubling from Q1 to Q2, the total number of network layer attacks observed in Q3 doubled again — resulting in a 4x increase in number compared to the pre-COVID levels in the first quarter.” And the attacks are getting worse. In August, CloudFlare fended off a botnet-based DDoS attack that amounted to 68% of all web requests they see on average. This particular attack did not come from one particular place; in keeping with the “distributed” nature of DDoS, the attacking traffic originated in 125 countries around the world.

Protecting the Infrastructure

Government and industry leaders are concerned about these surging attacks, but there are other threats as well. The scenario

of a lone hacker taking down the energy grid, or financial markets, or the telecommunications system is well known to movie goers. But real versions of these scenarios are very much on industry and government leaders’ minds. It’s important to protect our critical infrastructure, as we’ve seen with the Colonial Pipeline attack.

This challenge is a big one, but there is quite a bit of work being done. Government agencies are working with industry coalitions

Is Data Safe in the Cloud?

The cloud can be safer for data, but it is not entirely fool-proof. First, a common reason cloud systems are hacked is incorrect configuration. Hackers have automated the scanning of cloud accounts, looking for access privileges mistakenly left to the equivalent of “public”. This is like a criminal at night, going from car to car in a parking lot, looking for one left unlocked.

If the attacker has a user’s email credentials, they can encrypt email messages. Files infected on a physical device—like a laptop—will still be infected if they are synchronized to cloud storage. Many attacks start with phishing attacks – the sending of emails for what appear to be legitimate purposes – to surreptitiously obtain user login credentials.

The National Response to a Cyber Crisis

What happens in the event of a national cyber crisis? The Council to Secure the Digital Economy (CSDE) identified a dozen major scenarios that could potentially bring severe harm to the nation. The group identified how major stakeholders – ISPs, cloud service providers, software and hardware providers, and more – would need to come together to counter the attack. The scenarios include:

- DDoS Botnet Attack
- DDoS Server-based Attack
- Border Gateway Protocol (BGP) Hijacking
- Domain Name System (DNS) Hijacking
- Software Vulnerabilities: Open Source
- Software Vulnerabilities: Zero Day
- Hardware Vulnerabilities: Processor Architectures
- Injection of Malicious Code in Software and Hardware Components
- Destructive Malware
- Ransomware
- Advanced Persistent Threat (APT): Industrial Systems
- Cloud Provider Compromise

on multiple fronts. First, “critical infrastructure” has been a legally defined term since the Clinton Administration. It currently includes 14 categories including water and energy, information technology and telecommunications, agriculture and finance. These categories receive greater assistance with correspondingly greater responsibilities. After all, if you’re providing the nation with a service that, if crippled by a cyberattack, would have “a debilitating impact on security, national economic security, national public health or safety”, you should expect greater visibility and responsibility.

Consequently, industry leaders are working on cyber crisis scenarios and plans. The Council to Secure the Digital Economy’s [Cyber Crisis: Foundations](#) report lists a dozen major scenarios and details what action should be taken in each case.

And the consumer technology industry is part of all critical infrastructure at this point. Agriculture, finance, energy, and all other sectors use computers, networking equipment and connected devices from the consumer side. A major botnet-based DDoS attack took down over 100 of the most popular websites in the U.S. and U.K. in 2016. The attack kicked off a significant public-private partnership effort led by the National Institute of Standards and Technology (NIST). This led to an entire framework built from industry and agency efforts: baseline security guidance for all devices, a parallel consensus guidance from industry, technical standards and conformity assessment programs—all traceable back to the NIST guidance.

CTA’s own standards development group, Technology & Standards, in operation since 1924, is part of this consensus framework. The Cybersecurity and Privacy Management committee developed ANSI/CTA-2088 (“-2088”) as a direct expression of the guidance in the earlier documents. Engineers and developers rely on industry

consensus technical standards like -2088 to give them clear rules for development, and conformance groups use such standards to check to see if the device complies. Complying with standards like -2088 helps prevent IoT devices from being used as part of DDoS and ransomware attacks.



Criminal Financial Incentives

Ransomware, by its very nature, implies a financial incentive. Attackers demand payment for the key to decrypt corporate or consumer data. Companies don't always pay, but Colonial Pipeline famously paid the equivalent of \$4.4 million in a 2021 ransomware attack. And as mentioned earlier, hackers are now offering to pay the employees of a potential target for loading malware on their employer's systems.

There also is a robust market for hacking services on the "dark web". The dark web is a secretive part of the World Wide Web protected by special access software and used for illegitimate and illegal

activities. Stolen data, in the form of personal information like credit card numbers, social security numbers and passwords, is for sale on the dark web.

Originally, gamers were the ones growing the DDoS attack market on the dark web. When some skilled player in another city is cutting down your favorite character, it's possible to purchase a DDoS attack on that player. The flood of traffic slows their system response time, a phenomenon known as "lag", and a laggy gamer's avatar freezes on the screen, or moves slowly—easy to target and short-lived. Now DDoS attacks are for sale, averaging about \$10 per hour of attack, depending on the size of the attack (how much traffic, in gigabytes per second, will be sent to the hapless victim).

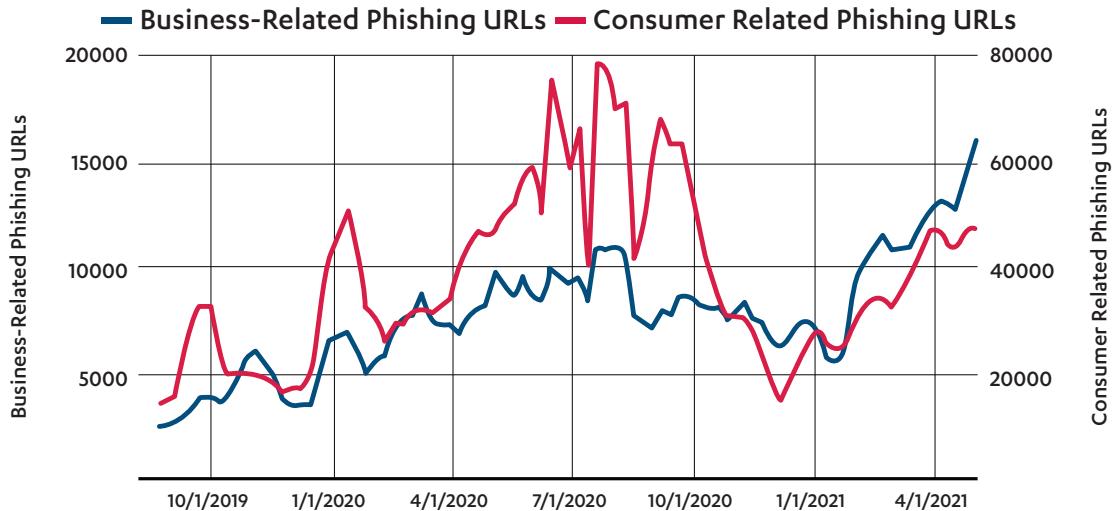
Insights and Strategies for Consumers

For a start, it's worth mentioning that everyone should be aware of good cyber hygiene practices. *Forbes* has a good list online.

And fortunately, consumer technology is getting more secure. "Smart firewalls" – like Akita, BitDefender, Cujo and Norton Core – can be installed between your internet service provider's router and the rest of the devices in your home. Amazon has added end-to-end encryption for its Ring doorbell product, meaning that the video is secured between the smart doorbell and your cloud video storage. If you're concerned about your email, there are services to encrypt it.

Besides personal protection, one might also consider the financial opportunities offered by investment in cybersecurity. With all the industry action and government focus on cybersecurity, it certainly sounds like a growth industry. It is, and in fact it's easy to invest in cybersecurity. CTA curates the NQCYBER cybersecurity index for NASDAQ, and there are several exchange traded funds

Business vs. Consumer-Related Phishing URLs



SOURCE: paloaltonetworks.com

(ETFs) that derive from it:

ETF Name	Bloomberg Ticker
First Trust NASDAQ Cybersecurity ETF	CIBR:US
Betashares Global Cybersecurity ETF	HACK:AU
First Trust NASDAQ Cybersecurity UCITS ETF	CIBR:LN
ProShares Ultra Nasdaq Cybersecurity ETF	UCYB:US

As far as the overall threat level for consumers, the bottom line is that there are two areas of concern. First, consumers should be aware of threats to their personal information. Phishing is used extensively

to attack corporations, but consumers get phishing emails too. The goal of a consumer phishing email is to get a consumer to click on malicious links that look like well-known social media brands, consumer banking and other popular consumer sites. This can expose personal information, especially credentials for logging in to sites—giving a malicious actor easy access to accounts.

During the pandemic shutdown, Palo Alto Networks found that consumer phishing attacks increased by roughly 100% from February 2020 to June 2020, as seen in the chart below. The message is definitely, “Think twice before clicking that link.”

Specifically, get in the habit of looking at the link address itself. Is the “domain name” (in the U.S., the last two parts) owned by

a company you trust? A common trick is to put a familiar name into (non-critical) locations ahead of the domain name. The link “google.evilhacker.com” is not owned or controlled by Google. But “literallyanything.google.com” is owned by Google, as indicated by the “.com” domain, and anything there can be trusted on the same level as google.com. The same is true for link addresses ending in .org, .tech, .edu, etc.—however, note that a country-specific code like “.ca” (for Canada) may be added at the end (like “stuff.google.com.ca”).



Also—hopefully it goes without saying, but be doubly careful whenever you are asked for login credentials. Check the address bar and domain name for the same kind of “who owns this” test as described above.

Another area of concern for consumers is connected device compromise. Hackers take over smart devices in order to build networks of computing and internet power that they can command

and control. These networks are called botnets and are one of the ways hackers create DDoS attacks. A compromised home device, like a printer, router or web camera, may act oddly. It’s no wonder, it’s under someone else’s control.

There are other concerns, including theft of data including camera video and banking credentials. It’s smart to secure your smart home.

And finally, if you’re attending CES 2022 January 6-10 in Las Vegas, make sure to check out the conferences. Privacy and cyber security will be important themes across multiple verticals in CES 2022 programming, such as the impact of cybersecurity on 5G. On that theme, one panel to check out is “Cyber Crisis Handling: Who You Gonna Call?” In this session, U.S. infrastructure cybersecurity experts from AT&T, Intel, Lumen and Oracle will talk about what to do in the event of a major cyberattack—their worst nightmare—and the consequent disruption of U.S. telecommunications and internet infrastructure.

Conclusion

Hackers have grown more bold, numerous and active. High-profile cyberattacks have become more common, and there are concerns about critical infrastructure. But there are quite a few efforts underway to push back, by industry working in partnership with government agencies, and there are some excellent proactive steps you can take to protect yourself as well. ■





5 TECHNOLOGY TRENDS TO WATCH
TRANSPORTATION

03

03

THE FUTURE OF TRANSPORTATION

BY ROBERT E. CALEM

From land to sky to orbit, transportation is undergoing a major makeover, much of it centered on the dual trends of electrification and autonomy. The vehicles of this transformation are multitudinous, ranging from trucks and buses to passenger-toting drones to rocket ships.

In many instances, the endeavors are being undertaken by companies that cross industries.



Fuel Cells and Batteries Gain Ground with Trucking

“We are on the verge of a paradigm shift in the transport industry,” says Lars Stenqvist, CTO and member of the Group Executive Board at Gothenburg, Sweden-based Volvo Group, which makes trucks, buses and construction equipment under many brand names including Volvo, Mack and Prevost. “A lot if not all will be engineering and technology driven,” Stenqvist says, “so for young engineers who want to work with something cool, the transport industry is definitely a place where it’s going to happen.” One of the major trends in this context is the move to “fossil free” vehicles, which he says will be completed worldwide by 2050 at the latest. But while that may seem like a long time away, he adds, because Volvo Group’s typical customer keeps a vehicle operating an average of 10 years, “that means everything we deliver from 2040 onwards must be fossil free, in all kinds of applications.”

One way to accomplish this transition is to use traditional internal combustion engines powered by synthetic diesel, biogas or hydrogen, which Volvo Group has already introduced.

Although he foresees “no end date” for internal combustion engines (ICE) in heavy commercial vehicles, Stenqvist says, the company believes there ultimately will not be sufficient biofuel in the world to support all demand for road transportation. “So we have come to the conclusion that the absolute majority of our vehicles by then will be electric,” he says. “They will be battery electric (BEV) and they will be fuel cell electric (FCEV).” Other manufacturers in the heavy commercial vehicle space are getting behind either BEV or FCEV, but Volvo Group is unique in that it’s backing both for the future, “and we think that the sweet spots for these technologies are a little bit different,” he asserts.

BEV technology is best for city applications such as garbage trucks and local or regional delivery vehicles that return to the



same garage or depot where they can be charged overnight. By comparison, FCEV tech — or a hydrogen-powered ICE — is ideal for tractor-trailer trucks that travel long distances nationwide, on different routes and variable schedules. These trucks can handle heavier payloads, offer greater range, and are more easily refueled, he explains.

These distinctions are not absolute, Stenqvist observes. For example, depending on their country or region of operation and its available infrastructure, some customers might opt for a fuel-cell powered city vehicle rather than a battery-electric version. In general, he says, BEV powertrains are more mature than FCEV equivalents, with the latter expected to be better developed by the second half of this decade.

“The trucking and commercial side of electrification is incredibly exciting because the economics of it for the end customers are very positive given the fuel savings, and from the environmental aspect

also,” says Tal Sholklipper, CEO and co-founder of Voltaiq Inc., a Berkeley, CA-based “enterprise battery intelligence” (EBI) software company that applies a big data analytics approach to battery product development, production and operation — for consumer electronics, stationary power and the transportation industry. Its customers include Ford, GM, Mercedes-Benz Research and Development of North America (MBRDNA), Stellantis and Proterra, which provides battery and electric drivetrain technologies for BEV school buses (Thomas), coach buses (Van Hool), delivery trucks (Volta) and excavators (Komatsu).



“Even last year, a lot of talk was around ADAS (advanced driver assistance systems) and connected vehicles. Right now the budgets are shifting towards electrification and EVs (electric vehicles) pretty broadly,” and commercial vehicles in particular “really prove the larger scale economics around EVs” by virtue of extensive utilization each day, Sholklipper says. Longer term, he adds, it’s the battery

pack that will contribute most to the residual value of an EV, “and that’s where analytics are key.” It’s important to know not only the state of the battery cell when it’s installed but “to continue to ascertain its health over time, both for early service reasons and ensuring reliability and safety, but also to underlie those economics and residual values for those products,” he says.

Voltaiq’s cloud-based EBI software platform captures data about each battery from the beginnings of its design in a laboratory through manufacturing and continually during its operating life in a vehicle. The company does not do this analysis itself, but rather, “we work directly with [vehicle manufacturers] and their supply chain and provide them with this capability,” Sholklipper says.

FCEVs are ripe for innovation, too. “When people talk about electric vehicles, they tend to use that as shorthand for battery electric vehicles. Fundamentally, an electric vehicle is one that has replaced the conventional powertrain [based on an ICE] with one that’s using electric motors to turn the wheels. But what generates that electricity? You can either have a bank of batteries that you recharge with electricity that’s generated elsewhere, or you can actually generate the electricity on the vehicle using a fuel cell,” says Thomas Stephenson, CEO and chairman of Pajarito Powder, LLC, an Albuquerque, NM- based company that has devised and supplies a proprietary catalyst used to make fuel cells.

Within a fuel cell, hydrogen stored in a tank is combined with oxygen that comes from the air, and through a direct chemical reaction accelerated by a catalyst, generates electricity and emits pure water out of the vehicle’s exhaust pipe. Normally that catalyst contains a large amount of platinum, which makes fuel cells enormously expensive.

Pajarito Powder’s innovation for the catalyst is a special spongelike, carbon-based material in which platinum particles can be suspended, enabling 50% less platinum to generate more power per square centimeter of surface area, cutting the total cost of the

fuel cell system by 20% and making FCEVs more financially feasible, Stephenson says.

For big-rig trucking, “it’s where the future is, you want the fuel cell,” declares R. “Ray” Wang, principal analyst and CEO of Constellation Research Inc., based in Palo Alto, CA. Both batteries and fuel cells need to be recharged — the latter in the sense that it requires refueling at a hydrogen station and both can be swapped out for new ones, when necessary, Wang points out. “It’s a real question of who can get which power source to a distribution point faster,” Wang says. Tesla has the capacity to produce battery packs and swap them in its Tesla Semi within 15 minutes, but FCEV truck makers like Volvo “will get there with fuel cells,” and that will lead to a race between the two technologies, he predicts. But “fuel cells don’t degrade” like batteries do and “fuel cells in the long run could actually cost four times less than lithium-ion batteries” and so therefore are preferable, he says.

The remaining challenge for fuel cells is to make them more efficient from start to finish, Wang says. Today, “only 25% to 30% of the energy [from the source hydrogen] makes it to the wheel of a fuel cell car,” versus 70% to 80% of the energy from a battery pack in a BEV, he adds.

One of the greatest advantages of FCEV over BEV for heavy duty trucks is the fueling infrastructure, which resembles diesel’s, says James Kast, a business development consultant at Toyota Motor North America’s research and development facility in Gardena, CA. Toyota began exploring fuel cells for these vehicles with a first prototype in 2017, a second prototype followed in 2018, and then the company debuted a “platform” demonstration truck with Kenworth at CES 2019. Now, the platform is incorporated in six Kenworth “Ocean” trucks distributed to customers who are using them regularly, as part of a test program operating out of the ports

of Los Angeles and Long Beach, CA. They’re able to travel 300 miles on a tankful of hydrogen, carry 80,000 pounds when fully loaded, and refuel in less than 20 minutes (compared with six hours to recharge an equivalent BEV truck), Kast says. Refueling time is expected to improve further, he says. The fleet is slated to increase to 10 Kenworth Ocean trucks in the future.

Additionally, Toyota’s subsidiary Hino has developed a light duty FCEV truck based on the automaker’s second-generation fuel cell technology for cars. The first prototype of this Hino truck debuted this summer at the Advanced Clean Technology (ACT) Expo in Long Beach, CA. It improves on the fuel cell’s power density, efficiency, weight and “packaging” — putting it up front where the engine normally sits — to “target diesel parity,” Kast says.

***“WE ARE ON THE VERGE OF A PARADIGM SHIFT
IN THE TRANSPORT INDUSTRY.”***

-Lars Stenqvist, Volvo Group

To be sure, fuel cells don’t obviate batteries, says Pajarito Powder’s Stephenson. In fact, it is standard for any FCEV to contain a combination of a fuel cell and a battery, which is used for acceleration and energy saving features such as regenerative braking.

“You need to have batteries and fuel cells to truly meet the breadth of mobility solutions that’s required in the electrified world we’re headed toward,” says Charlie Freese, executive director of the global hydrotech business at General Motors in Pontiac, MI. “The way to think about this is, today things that are moved by internal combustion engines that are gasoline driven tend to be well suited to battery electric propulsion systems. The bigger vehicles that have long haul requirements or heavy payloads – where diesels operate today and those technologies – will start to be replaced by hydrogen fuel cells coupled with the batteries for regenerative braking.”

eVTOL can Generate 18x more Revenue than a Ride Sharing Car

Economics Comparison	Ride Share Car ¹	Archer eVTOL Estimate ²
Average Trip Distance	25 Miles	25 Miles
Average Speed	25 MPH	150 MPH
Cost	\$1.50/Mile	\$3.30/Seat-mile
Average Time/Trip	60 Mins	12 Mins
Trips per Day	10	25
Days Worked	365/Year	365/Year
Revenue/Year	\$136,900	\$2,400,000

NOTE: Metrics in table compares a 25-mile ride share car ride home to the suburbs from the city to an eVTOL making the same 25-mile trip.

¹Illustrative example.

²Management Projections

SOURCE: Archer

A big-rig truck would have to jettison about 22% of its payload to accommodate the weight of a BEV powertrain, but only about 3% for a FCEV powertrain, Freese says, illustrating hydrogen's efficiency over batteries in this application.

Nevertheless, he contends, not every big-rig needs a fuel cell powertrain or could be a BEV, and the expected haul makes the difference. "If I've got a truck full of potato chips, I might be able to live with a BEV. But if I'm moving heavy payloads — steel, water, things like that — that's where hydrogen is providing the maximum benefit." GM's strategy overall has been to "develop a leadership position in both technologies and apply them where they fit," he says. Besides trucks, GM is integrating fuel cell propulsion systems in locomotives and aerospace vehicles, he notes.

Flying Taxis: eVTOLs and the Spread of Vertiports

Beginning by the middle of this decade, a ballooning number of passengers are expected to take to the skies in air taxis, generating skyrocketing revenues for related businesses and employing millions of people worldwide. At the core of this is a new type of electric vertical takeoff (eVTOL) aircraft. And the industry it serves is known alternately as Advanced Air Mobility (AAM) or Urban Air Mobility (UAM).

According to research from Deloitte Consulting LLP published last January, the AAM market space in the U.S. alone is estimated to generate \$115 billion of revenue annually by 2035 and 280,000 "high-paying" jobs. The article tags AAM "the next disruption in aerospace" by dint of eVTOL aircraft — either piloted or

autonomous — carrying cargo or passengers, linking urban centers with remote communities, and operating as air taxis within city boundaries. The passenger-carrying portion of the U.S. AAM market will generate \$57 billion by 2035, Deloitte predicts, and grow significantly thereafter.

“Transporting people in autonomous eVTOL aircraft could build on the success of transporting cargo,” Deloitte says. “Further, the success of initially piloted eVTOL operations will be the major driver for advances in autonomy. It could take off as an alternative mode of transportation, with operations primarily at airports and some dense urban systems. But over time, as the technology and infrastructure evolve, with denser vertiport buildout across cities, trips could become progressively longer, driving down the cost per mile to more affordable levels.”

More, a report published in November 2020 by the management consultancy Roland Berger, based in Munich, Germany, forecasts worldwide revenue from UAM at \$90 billion by 2050, with about 160,000 commercial air taxis flying in that year. Airport shuttle and inter-city services together will account for about 90% of those revenues, the company projects. “As a result, we expect a transition to a premium model of public transport in which UAM services will become increasingly similar to today’s taxi services,” the report says. There were 110 passenger UAM trials in cities globally last November, it says. It also portrays the development of an entirely new UAM ecosystem that encompasses airfields, flight operations, ticket brokerage and repairs.

Airlines long ago adopted a hub-and-spoke business model “because they need to get passengers en masse to one location,” says Constellation Research’s Wang. Yet, since an eVTOL aircraft requires only “a point” instead of a runway for takeoffs and landings — and that can be anywhere, including a strip mall parking lot — AAM does



Archer’s all-electric Maker enables urban aerial ridesharing

double duty for airlines, he says. It could provide new transportation options in remote places, plus add connections to a hub.

“We think this is a \$60 billion market by 2032,” inclusive of aircraft manufacturers and their suppliers, passenger travel and cargo, and maintenance, Wang says. “This is a real market.” As populations shift from cities to suburbs and farther away, and “we start moving away from density as a business model,” he expounds, “we need transportation solutions like this.”

One of the leading eVTOL aircraft makers is Joby Aviation, based in Santa Cruz, CA. Last year it acquired Uber Elevate, which had kickstarted the idea of eVTOLs as a would-be service provider, and Eric Allison, who led Elevate, is now Joby’s head of product.

The goal is a “vertically integrated service” with Uber, underpinned by a “vertically integrated manufacturing approach,” Allison says. Joby will have “first class placement into the Uber app,” and Uber’s

“ground-side service” will be available via the Joby app, he says, adding “we’ll have multiple entry points into our service when we launch it, in every market” where it’s offered.

Joby plans to launch its service commercially in 2024, with pricing initially set to be on-par with Uber Black car rides, eventually falling to UberX level. The company was founded in 2009, flew its first full-scale prototype eVTOL aircraft in 2017, and in 2019 began flight-testing a production prototype to pursue FAA certification. This year, Joby flew a full-size prototype 154 miles and performed a vertical take-off and landing all on a single charge. That set an AAM industry milestone and proves that Joby’s aircraft “has the flexibility to do both” short-range UAM flights and long journeys “that are really hard to do with any existing form of mobility in an efficient way right now,” Allison says.

“It’s about the everyday person taking these aircraft,” says Brett Adcock, co-founder and co-CEO of Archer Aviation, another leading AAM aircraft maker, based in Palo Alto, CA.

Archer is particularly targeting cities for a self-branded UAM ridesharing service, to help overcome traffic jams. Around Los Angeles, for example, trips under 50 miles can take more than one hour in a car but “we can just fly there in minutes,” Adcock says. To that end, he says, Archer intends to charge just \$3.30 per passenger per mile when its service scales. “This is needed in the world and it will happen,” he proclaims, outlining a plan to transition Archer’s eVTOL aircraft from piloted to semi-autonomous — surveyed by a pilot on the ground, like a drone — by the end of this decade, and later to fully autonomous flight.

In June, the company unveiled Maker, a two-passenger, fully autonomous demonstrator eVTOL aircraft. It has a range of 60 miles and a top speed of 150 miles per hour, and is 100 times quieter than a

helicopter. It is being used as part of Archer’s FAA certification plans ahead of commercial launch in 2024. But the aircraft Archer finally flies commercially will carry four passengers plus a pilot.

The auto industry sees the benefits of AAM and UAM, as well. Toyota has invested in Joby, and Stellantis has invested in Archer. Meanwhile, Hyundai has built an entire subsidiary to pursue the category — formally the Urban Air Mobility Division of Hyundai Motor Group, known as Hyundai UAM — which launched with a mock-up aircraft named S-A1 at CES 2020.

Of course, “UAM is just a fancy flying science project if you don’t have infrastructure for it to take off and land, and regulation to support it, and an air traffic management system that keeps the [flights] deconflicted and keeps us safe in our skies,” says Pamela Cohn, chief operating officer and U.S. general manager at Hyundai UAM in Washington, D.C. So, Hyundai UAM, like Archer and Joby, is building ecosystem partnerships simultaneous to developing its aircraft, Cohn says. To whet the appetite of potential customers, Hyundai UAM is expanding its outreach to the public. Next April it will host a two-week expo in Coventry, U.K., where visitors can experience augmented reality (AR) and virtual reality (VR) simulations of a trip on an S-A1.

“There’s still a pretty long pathway before the public is really ready to be getting onto these aircraft, and to have these aircraft fly over their homes and businesses and schools,” Cohn says. Hyundai UAM is planning for commercialization in 2028, which is when the company believes “everything coalesces,” she says.

Up, Up and Away

Beyond the sky is space — the final frontier in the future of transportation.

Overall, “the space economy” will grow to almost \$1 trillion over the next couple of decades, from \$340 billion in 2019, says the UBS Chief Investment Office, a research arm of the global financial services firm UBS AG. “While much of the excitement is focused on space travel, the Chief Investment Office sees opportunities in addition to tourism,” including the deployment of more satellite networks needed to satisfy bandwidth demand by proliferating automated cars and other internet-connected things, UBS wrote in an article it published in July. “Further into the future, CIO also sees the potential for asteroid mining and space-based manufacturing,” UBS says. “Over the next decade, launch costs are predicted to decline 10-fold. Part of this decline will be driven by the mainstream adoption of reusable rocket technology.” Both SpaceX (founded by Elon Musk) and Blue Origin (founded by Jeff Bezos) are expected to send medium-to-heavy payloads into geostationary orbit with their Falcon 9 and New Shepard reusable rockets, respectively, the UBS article notes.

Blue Origin’s New Shepard was launched into sub-orbital space in July for a 10-minute flight above Earth, with four passengers aboard. Earlier in the month, Virgin Galactic (founded by Richard Branson) and five crew members ventured even higher, to the edge of space, in that company’s own space vessel.

Topping those trips, SpaceX on September 15, conducted a mission named Inspiration4 to take a crew of four space tourists higher into actual orbit on its Dragon Capsule spaceship. The three-day excursion raised money for St. Jude Children’s Research Hospital. It splashed down off the coast of Florida on September 18. A Netflix documentary series covers it from run-up to homecoming.

“The challenge was getting to low-cost rocket launches,” says Constellation Research’s Wang. “We went from a model of government run to some light version of privatization to full public-

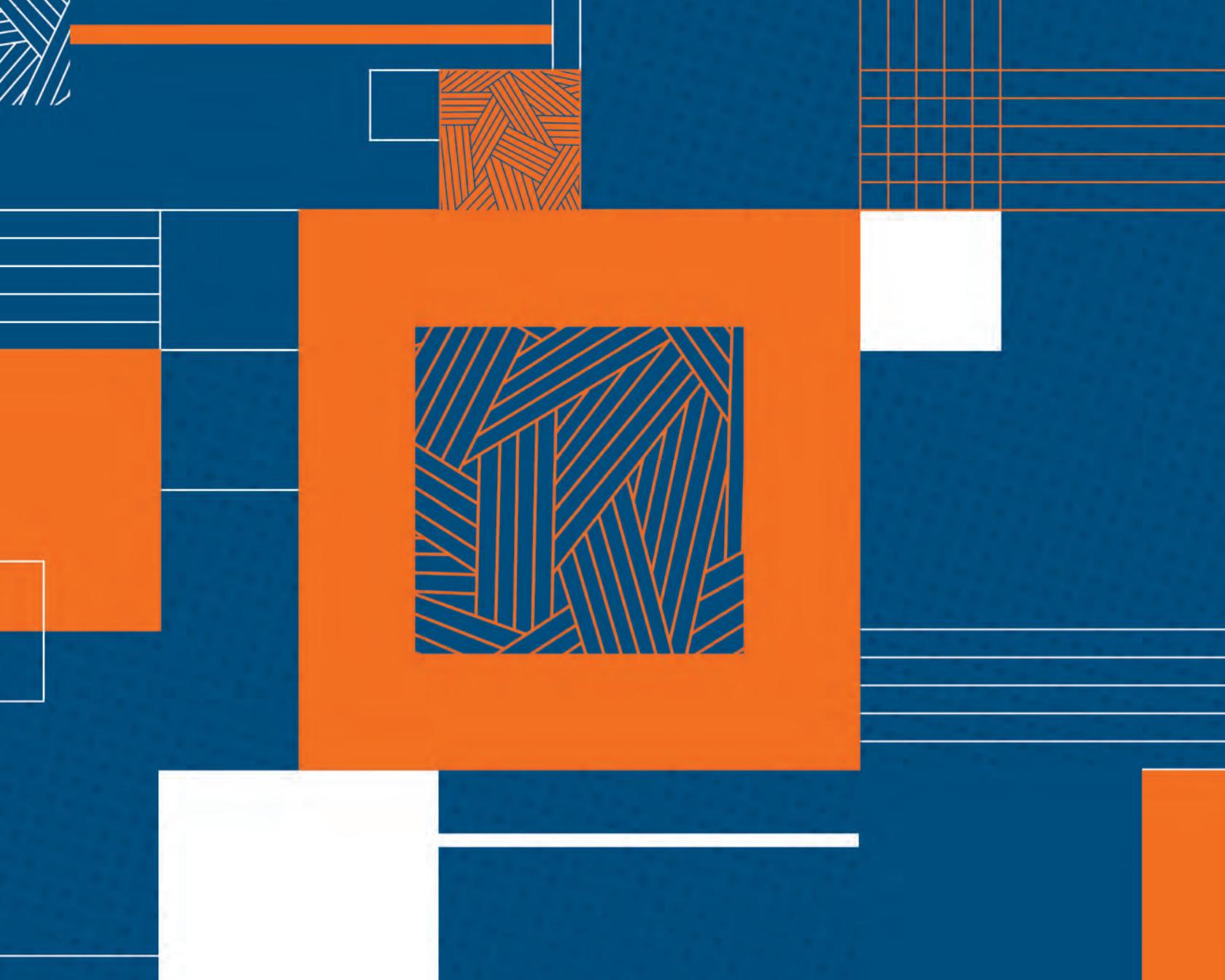
private partnerships, and this is probably the most exciting business model that’s going on in space,” he says. “But the real goal is doing space mining and space manufacturing,” and leveraging tourism to offset the costs, he declares. Space manufacturing may comprise growing human organs or new types of fiber optic cables; space mining on asteroids and the moon can yield a mother lode of metals and rare earth minerals, Wang says.

Aside from Blue Origin, Virgin Galactic and SpaceX, another emerging contender is Sierra Space, a subsidiary of the Sierra Nevada Corporation, whose forthcoming Dream Chaser spaceplane is designed to take off and land on a runway like an airplane and carry both cargo and people into low-Earth orbit. It is expected to begin cargo missions to the International Space Station next year, Wang notes. It also will be showcased in a new Space Tech category at CES 2022.

U.S. colonization of space and the manufacturing and mining that go along with it may be only 30 to 40 years away, he anticipates.

“Tourism is only a small piece” of what’s coming up in space, says Anthony Navarro, principal engineer at AstroNav Consulting, based in Littleton, CO. “If you can have a \$500 flight [through space] from New York to China and it takes you 30 minutes, that will be very utilized” for global commutes, Navarro says. “If you can wake up and have your meetings in China, or go to Europe for lunch, you’ll do that.” But “the bigger, long-term piece is logistics,” he says, invoking Jeff Bezos’ intent for Blue Origin to be the basis for a space travel infrastructure akin to the internet, upon which future entrepreneurs could build any business they imagine.

Trucks, eVTOL aircraft and space craft all share the same transportation foundation, Navarro concludes. “They have to get their occupants from point A to point B safely — even if it’s cargo.” ■



04

5 TECHNOLOGY TRENDS TO WATCH
FOOD TECH

04

TECH RESHAPING MEAT, EATING AND SUSTAINABILITY

BY NATALIE HOPE MCDONALD

Plant-based “meats,” AI-powered grocery experiences, 3D printed food, ghost kitchens and smarter delivery apps are all reshaping the food industry in diverse ways. As consumer habits shift because of smarter, newer tech innovations — and as tech developments are driven even more by consumer demand — the food tech industry is rapidly reconsidering what it means to access, order, cook and eat food.

In fact, there is no bigger industry on the planet than food and the businesses that surround it — from agriculture and delivery to cooking and consumption. In 2020, more than \$17 billion was invested in food technology solutions, according to FoodTech Data Navigator, while food and agriculture start-ups attracted a record \$22.3 billion in venture funding last year, twice as much as these segments raised the year before, reports Finistere Venture.



As more capital is being invested in food tech, the consumer technology industry is taking notice. For its part, CES has dedicated even more space to the food tech category since the world's first robotic kitchen debuted at CES 2021. Created by Moley Robotics in the U.K., the system featured a robot that helps prepare meals at the touch of a button within a luxury kitchen environment.

At CES2022, food tech is expected to be an even bigger breakthrough category, with spotlights on agriculture, ingredient innovation, meal kits and deliveries, nutrition, plant-based proteins, traceability, sustainability and vertical farming. Technology, says Karen Chupka, EVP, CES, is propelling the food industry "to new heights," appealing to enthusiasts, professionals, early adopters and mainstream consumers. It's expected that food technology's global market share will exceed \$342 billion by 2027, notably as the demand increases for access to cheaper, healthier and safer food products.

Where's the Beef?

Cultured meats are actual animal protein grown from living animal cells in a lab like San Francisco based Eat Just. However, Impossible Foods, an exhibitor at CES 2022 and an international game changer in the plant-based meat category thanks to its Impossible Burger, is accelerating its next-generation product development, including plant-based substitutes for steak, seafood, chicken, milk and eggs. Because cow product production is among the environmentally destructive technologies, says Impossible Foods Founder and CEO Dr. Patrick O. Brown, the Redwood, CA, company is doubling down on its research to advance plant-based food development.

Presently, Impossible Foods is valued at more than \$4 billion, with animal-free meat substitutes now widely available at major chains including Burger King and Starbucks. Beyond Meat, a close competitor, raised its first round of venture capital in 2011 and has quintupled in value since an initial public offering last year.

Overall, a record-setting \$3.1 billion was invested in alternative proteins in 2020, according to The Good Food Institute, which is more than half of the total \$5.9 billion invested in this sector during the last decade, and three times more than in 2019. Polaris Market Research predicts that plant-based meat alternatives will grow annually by almost 16% through 2027.

"Our stated goal since Impossible Foods' founding has always been to drive down prices through economies of scale, reach price parity and then undercut the price of conventional ground beef from cows," explains Brown. "Less than a year ago we cut food service prices by 15%." It's expected the price cuts will continue for both the burger patties and sausage made from plants, pushing them even further into cultural consciousness with the promise of a premium product at competitive price points.

CES HAS DEDICATED EVEN MORE SPACE TO THE FOOD TECH CATEGORY SINCE THE WORLD'S FIRST ROBOTIC KITCHEN DEBUTED AT CES 2021.

The Bigger Picture

Another food technology disrupter is Controlled Environmental Agriculture (CEA), which seeks to streamline feed for cattle while reducing carbon emissions and minimizing waste with less water use. With farmers expected to increase their output by 60% to feed the world's growing population by 2050, the issues are paramount, says Grov Technologies, a CES 2020 exhibitor that specializes in CEA.

Using a combination of engineering, plant science and computer-aided environmental control technologies, Grov is seeking to optimize plant growth and quality, as well as overall agricultural production efficiency.

"With a growing population, climate change and economic uncertainty, farmers are being asked to do more with less and find

Welcome to the Ghost Kitchen

The “ghost kitchen,” the new buzz phrase in food tech is a professional food preparation and cooking facility set up to prepare delivery-only meals. It is not only helping to reshape the way restaurants prepare, manage and deliver food, but also how would-be entrepreneurs launch their businesses in a pandemic world. As a considerably lower risk option than investing in a brick-and-mortar, these so-called ghost kitchens are cutting front house costs and real estate while maximizing on delivery. Kitchen Robotics, a developer of ghost kitchen solutions in Israel, has created a few different tech options that are fully programmable, easy to operate and cloud-compatible. Ofer Zinger, the company’s co-founder, explains how it all works.

How did you get started in food tech?

We developed the Beastro, the world’s first robotic dark kitchen. Kitchen Robotics is revolutionizing the space not just by automating the entire cooking process, but by creating a fully programmable and controlled environment in which the cooking process takes place.

What does Beastro do?

Beastro is not only capable of cooking thousands of different dishes, but it is also a part of a fully controlled cloud-based environment that keeps track of analytics, quality, costs, timing, connectivity to third parties, optimizations and much more.

What are some challenges the industry faces?

The restaurant space suffers from multiple challenges that have only worsened during the COVID-19 pandemic. To mention some: labor cost and lack of labor; hygiene, food quality and allergens; dish consistency; financial risks within the restaurant space; and lack of visibility and control of operations.

How will food tech evolve in the next few years?

I believe that automated solutions will become more common in the years to come through the entire supply chain. I predict more order and delivery automation and the rise of demand side platforms (DSPs); cooking automation; personalization of dishes, and attention to diets, allergens and personal taste; alternative proteins and better attention to environmental impacts; demographic and generational gaps affecting the total available workforce; and data collection and the usage of its analytics for optimization.

innovative ways to overcome these challenges,” explains Steve Lindsley, Grov Technologies’ president. Using the research and science-based growing protocols, the company created its largest controlled environmental agricultural, the Olympus Tower Farm, an automated indoor growing system for commercial scale production of fresh animal feed. The bigger goal is to help dairy and beef producers become more sustainable and economically viable in a world facing a climate crisis.

Taking up less than 900 square feet of space, Olympus Tower can produce up to 6000 pounds of sprouted wheat and barley grass per day using less than 5% of water than would normally be used to create the same surplus. Lindsley says the solution replaces up to 50 acres of traditional farming, which is a major consideration as the meat and dairy industries are at a turning point over issues of sustainability. He says, “Increased consumer demand for traceable, local food and the agricultural risks associated with climate change have made it essential for farmers to adopt sustainable technologies.”

The App Revolution

As the food industry itself faces unprecedented challenges in production, demand and regulations, consumer demands have also changed considerably during the pandemic. For example, an increased demand for fresh and fast access to food has put significant pressure on the food industry to innovate, making food delivery apps, like DoorDash, Instacart and UberEats, game changers in the way food gets from restaurants and grocers to customers at the touch of a button.

According to Leah Seay, UberEats spokesperson for communications and delivery, the company has partnered with 700,000 merchants in more than 6000 cities globally, while keeping average delivery times under 30 minutes. “Uber delivers instant access to local commerce,” says Seay. “We help people discover local merchants, order meals, groceries, and more at the touch of a button—and get it delivered reliably and quickly.”

The pandemic lockdown inspired more consumers to use the apps to access food, a convenience that appears to have staying power. Seay expects the service to continue to grow. “By broadening our global ordering and delivery offerings into grocery, convenience, alcohol, specialty goods, pet supplies,

flowers and more,” she says, “we’re leveraging the best of Uber to move what matters within hours if not minutes—to the benefit of consumers, local merchants, and of course, earners with increased delivery opportunities.”

Tech-based delivery apps are also looking to new innovations to streamline the experience. San Francisco-based Instacart could potentially enlist robots for in-store shopping, which would replace human gig workers that are becoming increasingly harder to come by due to labor shortages. Bloomberg first reported in June of 2021 that the company would ultimately need to build automated fulfillment centers across the country with hundreds of robots transporting boxed and canned food, leaving humans to pick produce and deli items.

IN 2020, MORE THAN \$17 BILLION WAS INVESTED IN FOOD TECHNOLOGY SOLUTIONS.

-FoodTech Data Navigator

Presently, Instacart uses thousands of gig workers to shop and deliver groceries, with consumers paying upwards of 25% in delivery fees, tips and price hikes per order. The popularity of these services grew during the pandemic, and are expected to keep growing now that they have, in a sense, been mainstreamed.

In its *Beyond the Cart: A Year of Essential Insights*, Instacart explores how the pandemic changed its business model and the way people shop for food. One of the most revealing finds is that seniors accounted for the largest jump in Instacart users compared to any other age group. To date, nearly 300,000 seniors have learned to use the app with the help of Senior Support Service. And according to a Harris Poll of those who bought groceries online during COVID-19, 77% say they are likely to continue to do so in the future.

Instacart predicts that the future of food access will be defined by a few factors, including:

- **Speed and Convenience**

When presented with delivery options including two-hours or less delivery, five-hour delivery and other scheduled options throughout the day, 85% of customers opted for delivery within two-hours or less. In 2020, 95% of small orders were delivered in under two hours and 50% were delivered in less than one hour.

- **Adds Accessibility**

Post-pandemic, the profile of the online grocery delivery customer will continue expanding to both younger and older customers. The use of the technology by seniors has been growing by about 1000 senior customers daily.

- **A Personal Touch**

Now that customers have spent a year communicating directly with their shoppers, there will likely be a boost in chat functions. Elevated use of phrases and emojis that communicate gratitude suggest customers will retain a deeper sense of appreciation for their personal shoppers.

With demand for food e-commerce growing, thanks to everything from front-door deliveries to meal kits, food tech companies raised about \$17.3 billion in 2020. Of this, 68% went directly to the e-commerce and delivery businesses. And meal kits alone raised \$6.2 billion, while e-commerce companies raised \$5.3 billion.

It's expected that delivery platforms will dominate the food tech space even more in the coming year, thanks to smarter options for consumers. For example, so-called ghost kitchens are already helping to create delivery-only brands that are gaining in popularity

even if they never had a brick-and-mortar presence in the first place. In addition, third-party fulfillment centers that cook and batch for a variety of brands, are expected to increase their market presence, according to *Fast Company*. These are literally places where food is made to ship out rather than eat in. All of this will be happening while changes continue to shape the playing field, like Uber acquiring Postmates, DoorDash going public and Grubhub being sold.

In fact, a new swath of delivery platforms will also likely be shaped, in part, by evolving consumer behaviors and demands post-pandemic with an increase on customization. GoPuff in the U.S., for example, will deliver convenience items and alcohol in cities in less than 30 minutes, while Instacart and other grocery-only platforms will likely expand to include many more deliverable goods outside of food.

What Consumers Want

Today's consumers have an abundance of food options at the tap of a smartphone button. But more than ever, tech-savvy users are truly seeking nutritious food that can be accessed easily, with limited waste from companies that align with their personal tastes and ethics. Spending trends suggest that consumers are willing to pay much more for convenience and better quality overall, especially if the food they order is healthy and has a far less negative environmental impact.

A big part on this farm-to-table e-commerce niche are companies that ship ready-to-use meal kits like Hello Fresh, Daily Harvest and Blue Apron, all of which grew in popularity during the pandemic. Designed to eliminate the need to shop for ingredients or to even know how to cook, the kits have become a fast-growing category since the first one was introduced in 2012. According to Statista, at the current trajectory, meal kit revenue is expected to grow to more than \$7.6 billion by 2024, an increase from \$2.5 billion in 2017.

What makes the kits so appealing is the sheer variety of cuisines being offered, the freshness of ingredients and the ease of use, like being able to put together ingredients to make a restaurant-quality meal at home, even for consumers who may not know their way around a kitchen. There is also the connection people have cooking together, something that exploded in popularity during the pandemic.

By 2022, the meal kit industry is expected to be worth \$11 billion in the U.S. alone, skewing younger in terms of consumers. A Money-Blue Consult survey revealed that more than a quarter of Generation X and almost 30% of millennials had used the meal kit service. But when it comes to Baby Boomers and older generations, only about 12% tried the kits.

The biggest demographic for the kits tends to be mostly urban, primarily male consumers that earn six figures. American consumers who use the kits (81%, according to a Harris Poll) say they thought they were ultimately healthier compared to take-out options. The same consumers also seem to prefer meals at home to eating out, with health-consciousness shaping what they order.

Overall, the idea of “big food” is becoming less appealing than “small food,” according to EY, a think tank connected to Ernst & Young Global Limited. Food by design, the idea that nutrition can be customized sustainably and delivered easily, will potentially reform the way people eat, what they eat and how technology impacts the global supply chain and, perhaps even more significantly, human health.

With more personalized, localized eating becoming a major driver of the food tech world, companies will have to consider what role they ultimately play. Consumers will continue to influence how the industry pivots to account for cultural and scientific changes, global and climate challenges and ultimately how we all think about what we eat and how. ■

Bot Com: Inside AI-Powered Delivery

Hungryroot, an AI-powered delivery service, hopes to take automation a step further when it comes to online grocery ordering in the U.S. The focus is on customization, convenience and healthy choices, three major drivers of food tech.

Based in New York City, Hungryroot uses a customer’s order history and algorithms to predict not only what foods they are likely to order, but what groceries are best suited to their health goals, family size and budget. A user can even receive recipes to help craft meals easily based in ingredients delivered.

Think of it as the Netflix of food ordering. The service literally selects new options based on previous ordering history, which has attracted investors. The startup raised \$40 million in funding as of June 2021.

“We’re creating a new category,” explains Hungryroot Founder and CEO Ben McKean, “by bridging a gap between the broken in-store and online grocery experience, with an added emphasis on personalization.” It offers the convenience of online shopping and delivery with the feel of a meal kit solution.

“Through our online grocery service and personalization algorithm, consumers will instead receive a weekly delivery of healthy food options and recipes specifically customized to their personal preferences.”



05

5 TECHNOLOGY TRENDS TO WATCH
DIGITAL
THERAPEUTICS

05

THE STRENGTH OF THE
DIGITAL THERAPEUTICS
MARKET

BY MURRAY SLOVICK

In an old *Saturday Night Live* sketch Billy Crystal, playing the talk show host “Fernando,” had as one of his tag lines, “You know, it is better to look good than to feel good.” Well, that was way back in the 1980s and today, if developers of digital therapeutics (DTx) have their way, “look good” and “feel good” will no longer be mutually exclusive. And given the pandemic, more people might choose the latter over the former.

DTx uses software to enhance clinical decision making, helping to determine the dose and method of delivery of medical treatment. DTx software can prevent, manage or treat a broad spectrum of physical, mental and behavioral conditions. DTx products empower patients with self-management tools. They are used independently or in concert with medications, devices or other therapies to optimize patient care and health outcomes.



Examples range from digital exercise programs specifically designed for patients with diabetes to virtual reality-based mental health apps for patients with post-traumatic stress disorder (PTSD), aiming to reduce dependence on drugs. Software can be prescribed like medication, such as a mobile game to improve attention in kids with ADHD (Attention Deficit/Hyperactivity Disorder) that employs connected consumer devices that feed data back to the user's physician to adjust treatment and prescriptions.

DTx products must be proven as effective via stringent testing. Published results must include clinical trial results demonstrating that each technology is safe, effective, credible and delivers clinically meaningful outcomes. DTx is generally used to deliver health information, provide cognitive or motivational support, supplement and enhance treatment with drugs or other medical technologies, and capture data.

DTX PRODUCTS EMPOWER PATIENTS WITH SELF-MANAGEMENT TOOLS.

DTx delivers behavioral therapies via software like mobile health apps that complement the existing treatment of a disease. With software as its means of intervention, DTx products demonstrate significant benefits in the management of patients with challenging conditions, especially in the area of mental health including psychiatry, addiction, neurology, substance abuse and sleep medicine. DTx's patient-directed 24/7 access and affordability are delivering an effective therapeutic alternative to traditional mental health care, alongside traditional medication.

DTx uses software applications to enhance clinician decision making, optimizing the dose and delivery of other forms of medical treatment through monitoring patient data in real time, or acting as a standalone intervention.



Creating Definitions

The current challenge is the multiple terms used within the industry. To date, the digital therapeutics field does not have a standard lexicon. There is no common industry definition of a digital therapeutic. It's been described by Kerri Haresign, CTA director, technology and standards, as a kind of leading edge for CTA. "We look at that term in the context of the broader ecosystem of digital health. The goal is to set an industry standard on the common use and application of this technology, and educating consumers in the process," she said.

Haresign added, "Many of us have a step counter whether it's a Fitbit or an Apple Watch to encourage us to lose more weight and track our activity. But let's say there's somebody who is diabetic and their doctor said they have to walk two miles per day in order to keep their diabetes in check. In that case, then, the fitness tracker, if it's used for the purpose of treating a disorder, would be considered

All products claiming to be a digital therapeutic must adhere to these foundational principles:

- Prevent, manage, or treat a medical disorder or disease.
- Produce a medical intervention that is driven by software.
- Incorporate design, manufacture, and quality best practices.
- Engage end users in product development and usability processes.
- Incorporate patient privacy and security protections.
- Apply product deployment, management, and maintenance best practices.
- Publish trial results inclusive of clinically-meaningful outcomes in peer-reviewed journals.
- Be reviewed and cleared or certified by regulatory bodies as required to support product claims of risk, efficacy, and intended use.
- Make claims appropriate to clinical evaluation and regulatory status.
- Collect, analyze, and apply real world evidence and/or product performance data.

SOURCE: *Digital Therapeutics Alliance (dtxalliance.org)*

a digital therapeutic device because it's used in that kind of targeted application."

One of the things that would be included in any upcoming definition is that it must be evidence-based. It could be a digital solution that is used in conjunction with a traditional pharmaceutical or medical solution. "So, again," said Haresign, "using this example, you may think about a therapeutic device as you would think about a traditional drug treatment, which is going to have evidence of how it helped to solve a problem."

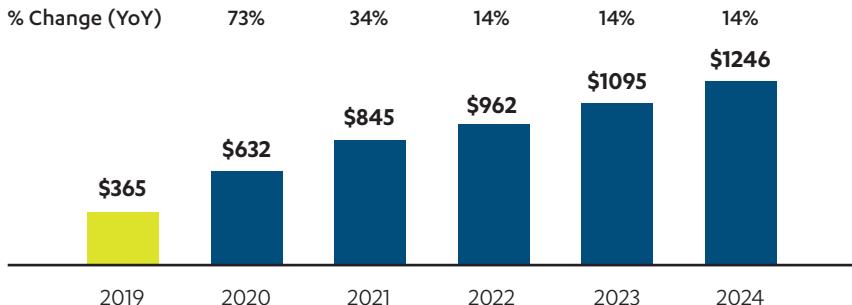
Consumer tech and digital health companies are joining a new push for industry-wide digital therapeutics standards. CTA has been working with a number of health technology companies in developing these standards.

Haresign said, "CTA is uniquely placed to help drive this conversation and definition because we have a very diverse set of stakeholders sitting at the table. Within CTA we have leading digital health companies and some companies that are really purely digital therapeutics solution providers. And then, of course, working with CTA comes with the big digital tech firms as well."

CTA member interest in DTx products stems from the fact that the software is accessible through devices such as smartphones and tablets. From the patient perspective, DTx offers convenience and privacy. That many are available only via prescription also positions the healthcare provider to play an active role in administering DTx therapies and in patient monitoring and outcomes assessment.

CTA's initiative is not the only group to push for consistent standards. "An organization that's been engaging with us directly is the Digital Therapeutics Alliance," said Haresign. "CTA is a very collaborative organization, so we welcome others that want to to come to the

Five-Year Forecast; Connected Health Monitoring Devices U.S. Shipment Revenue (\$Million)



SOURCE: CTA Market Research

table. We have sent some outreach to the regulators, for example, to give us input.”

CTA AND THE CONNECTED HEALTH INITIATIVE ARE LEADING THE HEALTH EQUITY AND ACCESS LEADERSHIP (HEAL) COALITION.

A Booming Market

The surging prevalence of chronic conditions combined with long term effects of the pandemic is fueling growth in the booming global DTx market. According to a reportlinker.com study entitled *Global Digital Therapeutics Industry* the global market for digital therapeutics was estimated at US\$347.2 million in the year 2020 and is projected to reach US\$1.6 billion by 2027, growing at a CAGR of 24.6% over the period 2020-2027.

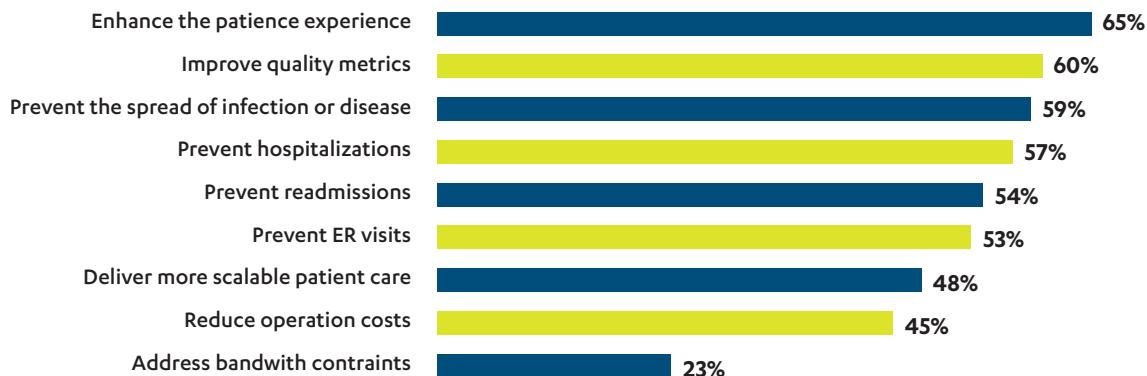
However, Pitchbook includes digital therapeutics under the umbrella of “virtual health.” It states the global digital therapeutics market is currently valued at \$2.1 billion and expected to reach \$11.1 billion by 2025 at a CAGR of 26.8% (March 2021 for Q4 2020).

CTA and the Connected Health Initiative are leading the Health Equity and Access Leadership (HEAL) Coalition, a multi-sector initiative of tech companies, health care providers and public agencies examining new ways to leverage technology to reduce health disparities across diverse demographics and communities. The group’s first project will be a white paper with policy and operational recommendations on technology’s role in tackling disparities in the American healthcare system.

According to a report by the IQVIA Institute for Human Data Science *Digital Health Trends 2021: Innovation, Evidence, Regulation,*

Remote Care Delivery: Perceptions Adoptions and Trends

In the past 12 months, what are the reasons your organization has invested in technologies that allow you to deliver care outside of the hospital:



SOURCE: Current health study: "Remote Care Delivery: Perceptions Adoptions and Trends, 2021"

and Adoption, over 250 such products are now identified, including about 150 products commercially available (the rest are in development). So far, at least 25 digital therapeutics have been granted market authorization by the Food and Drug Administration, according to the report. Another 23 are commercially available, with some behavioral health apps exempted from FDA requirements to submit a 510(k) premarket notification during the pandemic. The IQVIA report identified 89 digital therapeutics still in development.

Furthermore, apps are increasingly focused on helping consumers manage their health conditions rather than on wellness management. Consumer disease management apps now account for 47% of the most widely used digital health apps in 2020, up from 28% in 2015.

Apps for mental health, diabetes, and cardiovascular care account for almost half of the disease-specific apps. Simultaneously, digital therapeutics and digital care products incorporating software as a means to treat, prevent or manage specific diseases or conditions are growing in volume and gaining reimbursements.

Also encouraging are suppliers such as Happify recently announcing new products, in this case Ensemble, a transdiagnostic prescription digital therapeutic for the treatment of patients who have Major Depressive Disorder (MDD) or Generalized Anxiety Disorder (GAD). Designed as an adjunct to care for MDD and GAD, Happify's Ensemble is accessible via smartphone or computer, and teaches patients new skills and habits to take control of their anxiety and depression.

Digital Health, Digital Medicine, Digital Therapeutics (DTx): What's the Difference?

DIGITAL HEALTH

DIGITAL MEDICINE

DIGITAL THERAPEUTICS

	DIGITAL HEALTH	DIGITAL MEDICINE	DIGITAL THERAPEUTICS
Definition	Digital health includes technologies, platforms, and systems that engage consumers for lifestyle, wellness, and health-related purposes; capture, store or transmit health data; and/or support life science and clinical operations.	Digital medicine includes evidence-based software and/or hardware products that measure and/or intervene in the service of human health. ¹	Digital therapeutic (DTx) products deliver evidence-based therapeutic interventions to prevent, manage, or treat a medical disorder or disease. ²
Clinical Evidence	Typically do not require clinical evidence.	Clinical evidence is required for all digital medicine products.	Clinical evidence and real world outcomes are required for all DTx products.
Regulatory Oversight	These products do not meet the regulatory definition of a medical device ³ and do not require regulatory oversight.	Requirements for regulatory oversight vary. Digital medicine products that are classified as medical devices require clearance or approval. Digital medicine products used as a tool to develop other drugs, devices or medical products require regulatory acceptance by the appropriate review division.	DTx products must be reviewed and cleared or certified by regulatory bodies as required to support product claims of risk, efficacy, and intended use.

¹ dimesociety.org/index.php/defining-digital-medicine

² dtxalliance.org/dtxproducts/

³ It is important to check with local regulatory requirements in each jurisdiction the product is manufactured, registered or used in.

SOURCE: "Digital Health, Digital Medicine, Digital Therapeutics (DTx): What's the difference?" Authors: The Digital Medicine Society (DiMe)

“Data shows that people with MDD are 5.7 times more likely to have GAD than people without MDD. Additionally, 20% of people with major depressive disorder also meet criteria for GAD in a given 12-month period,” said Chris Wasden, Head of DTx at Happify Health. “With mental health disorders exploding as a result of the pandemic, significant shortages of mental health clinicians, high costs of treating mental health disorders, and a high degree of variability in applying Cognitive Behavioral Therapy, mindfulness, and positive psychology to treat these patients, clinicians need an evidence-based therapy like Ensemble.”



Similarly, Ginger has announced on-demand mental healthcare access for adolescents. Ginger for Teens will provide individuals ages 13-17 with access to Ginger’s self-guided content, 24/7 on-demand and scheduled coaching and video therapy and psychiatry

sessions. Ginger for Teens aims to provide adolescents with mental health support through a smartphone. The Ginger app will be available to adolescents by invitation from a parent who is eligible for Ginger as a benefit through their workplace. Over 25 million people in over 50 countries around the world have access to Ginger through employers, health plans, and partners. This offering will be available to all Ginger clients and members by 2022.

Treating Pain

Chronic pain is the number one cause of long-term disability in the United States and affects more Americans than diabetes, heart disease, and cancer combined. Delivering personalized guidance to patients with chronic pain can help them better manage their condition and improve their resiliency.

Software developed by Finnish drugmaker Orion is aiming to address chronic pain conditions using virtual reality (VR) devices that provide a game-like therapeutic treatment program. In a clinical trial Orion’s treatment has shown statistically significant benefit over passive (placebo) control and standard care interventions for fear of movement, patient clinical global impression of change (PGIC) and quality of life in adult patients with chronic low back pain (CLBP).

The therapy uses a VR headset to guide people with chronic pain through a series of cognitive behavioral therapy (CBT) exercises designed to help them overcome the fear of movement – also known as Kinesiophobia — and then re-engage in an active life. The modules are presented in a personalized mode that can be tailored to the patient’s needs. Orion developed the software in close collaboration with Professor Christopher Eccleston, a pain specialist from the University of Bath, and technology group Healthware. Results from Orion’s pilot study ‘VIRPI’ were announced at the IASP 2021 Virtual World Congress On Pain.

Virtual reality can help airmen and soldiers self-regulate stress and brain waves to manage mental well-being. Healium, a CTA member and CES 2019 AARP Pitch Competition winner, leverages AR/VR and the body's electricity waves to combat mental health concerns and stress.

Healium has been awarded a U.S. Air Force contract to explore deploying its mental fitness products to service members. Healium products allow users to biometrically alter their virtual environment through emotions and subsequently decrease their own stress. Powered by the user's brain patterns and heart rate, the product lets users heal by promoting the user's positivity and sensations of healing.

HEALIUM PRODUCTS ALLOW USERS TO BIOMETRICALLY ALTER THEIR VIRTUAL ENVIRONMENT THROUGH EMOTIONS AND SUBSEQUENTLY DECREASE THEIR OWN STRESS.

As the user reaches different states of focus or quiet of the mind, the Healium headband picks up the brainwave pattern changes and powers the VR experience forward. As the accompanying smartwatch picks up the decreasing heart rate, the AR environment will also adjust accordingly.

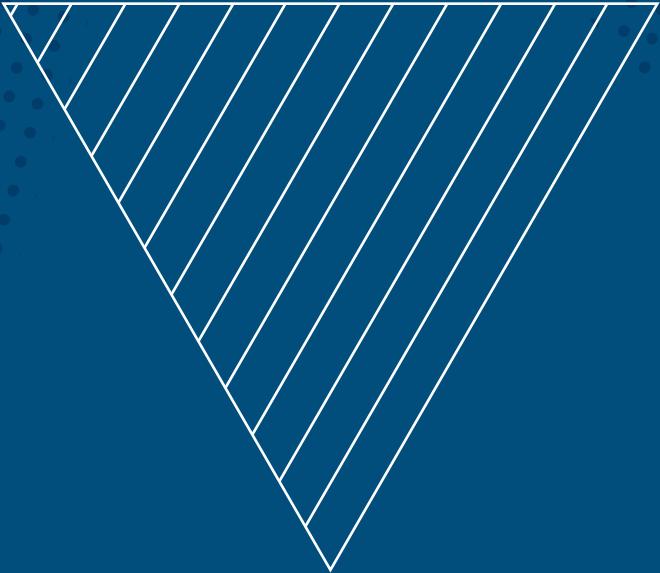
Focus on Stress

"Going forward," said Haresign, "CTA is looking at standards for stress monitoring solutions and proposed requirements targeted at acute stress applications. Obviously, mental health is a huge topic and of huge interest. We know now — after the last year and a half — it is an opportunity for CTA to be a leader on this and to use data to identify some of the common best practices in the field."



"Specifically with mental health," Haresign continued, "CTA wants to focus on chronic stress. We see it as an opportunity for technology to really change the space. So our standard is going to look at a number of different things, outside of doing some definitional work as we often do, to look at what are some of the factors or the metrics to think about as we develop some of these solutions."

CTA is expecting a standard to come out on this topic in early 2022 covering characteristics and requirements for mental health technology solutions. It will provide guidelines and implementation for consumer technologies related to the monitoring, treatment, and diagnosis of mental health and mental wellness. ■



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