#TechVision

Accenture Digital Health Technology Vision 2022

Meet Me in the Metaverse

How the continuum of technology and experience is reshaping healthcare

accenture

Preface

We are on the threshold of a new decade of digital transformation, and at a defining moment for all leaders. Welcome to the **"Metaverse Continuum"**—a spectrum of digitally enhanced worlds, realities and business models poised to revolutionize life and enterprise in the next decade—and the impact on healthcare begins today.

While there are many components, we see the metaverse as having two primary functions: Creating the "Internet of Place" and the "Internet of Ownership." Soon, new spaces in the metaverse will transport us to almost any type of world we can imagine, letting us interact with clinicians, peers and enterprises at a distance ("Internet of Place"). And healthcare organizations will shift part of their operations to the metaverse, maintaining their own internal virtual environments so employees can work from anywhere and collaborate in new ways based on data that can be validated and authenticated by the employee and the patient ("Internet of Ownership"). This way of life seems futuristic, but it's already on its way here.[1]

Early signals of the Metaverse Continuum indicate that the entire healthcare C-suite should think about tomorrow differently. Just as when the internet first arrived, healthcare businesses must now push through a new wave of technology disruption. Especially while understanding that the metaverse is not an end state or a discrete technology, rather it is an evolving set of possibilities for how we live our life. This time, enterprises have warning of what's to come and can start making strategic investments today.

As we build this new universe of care and financing, technology is the essential enabler, but we must not lose sight of the most important element: People. We can modernize care and humanize it at the same time. This will require igniting the digital foundation you are putting in place today, applying new radically human technologies[2] to transform the future of your organization.

Only with a high-performing digital core could healthcare enterprises be prepared to participate in, or even build, the next evolution of the internet—creating greater access, better experiences and improved outcomes while keeping people at the heart of it. Every healthcare leader will need to ask: What will be my organization's role in this new continuum? What is my vision for succeeding in these future worlds while delivering equitable, accessible care to all?

> Technology is the starting point.
> The rest of the journey is up to you.

Rich Birhanzel
Senior Managing Director,
Global Health Industry Lead
Accenture

97%

of healthcare executives believe continuous advances in technology are becoming more reliable than economic, political or social trends in informing their organization's long-term strategy.

Our Four Technology Trends for 2022

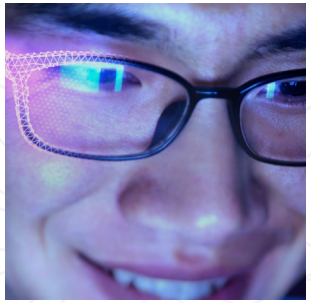
This year's Accenture Digital Health Technology Vision explores four trends that reveal how new technology innovations are reshaping healthcare experiences of the future.

WebMe

Illustrates how the internet is being reimagined with the metaverse as an experience layer and Web3 as a new distributed data layer. In the metaverse, rather than viewing digital content, people will be present with it. With Web3, data will move with the person and not the platform.

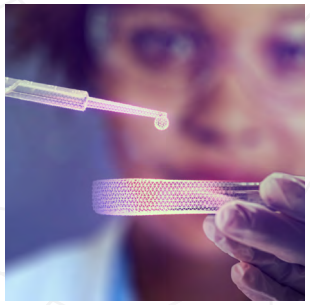
Programmable World

Tracks how technology is being threaded through our physical environments in three layers: connected, experiential and material. 5G, ambient computing, augmented reality, 3D printing and smart materials are converging in sophisticated ways, turning the physical world into an environment that is as smart, customizable and as programmable as the digital one.



The Unreal

Explores the "unreal" qualities that are becoming intrinsic to artificial intelligence, and even data, making the synthetic seem passably authentic. Synthetic data and synthetic content can be both helpful and harmful, so we must look through a continuous lens of verifying authenticity.



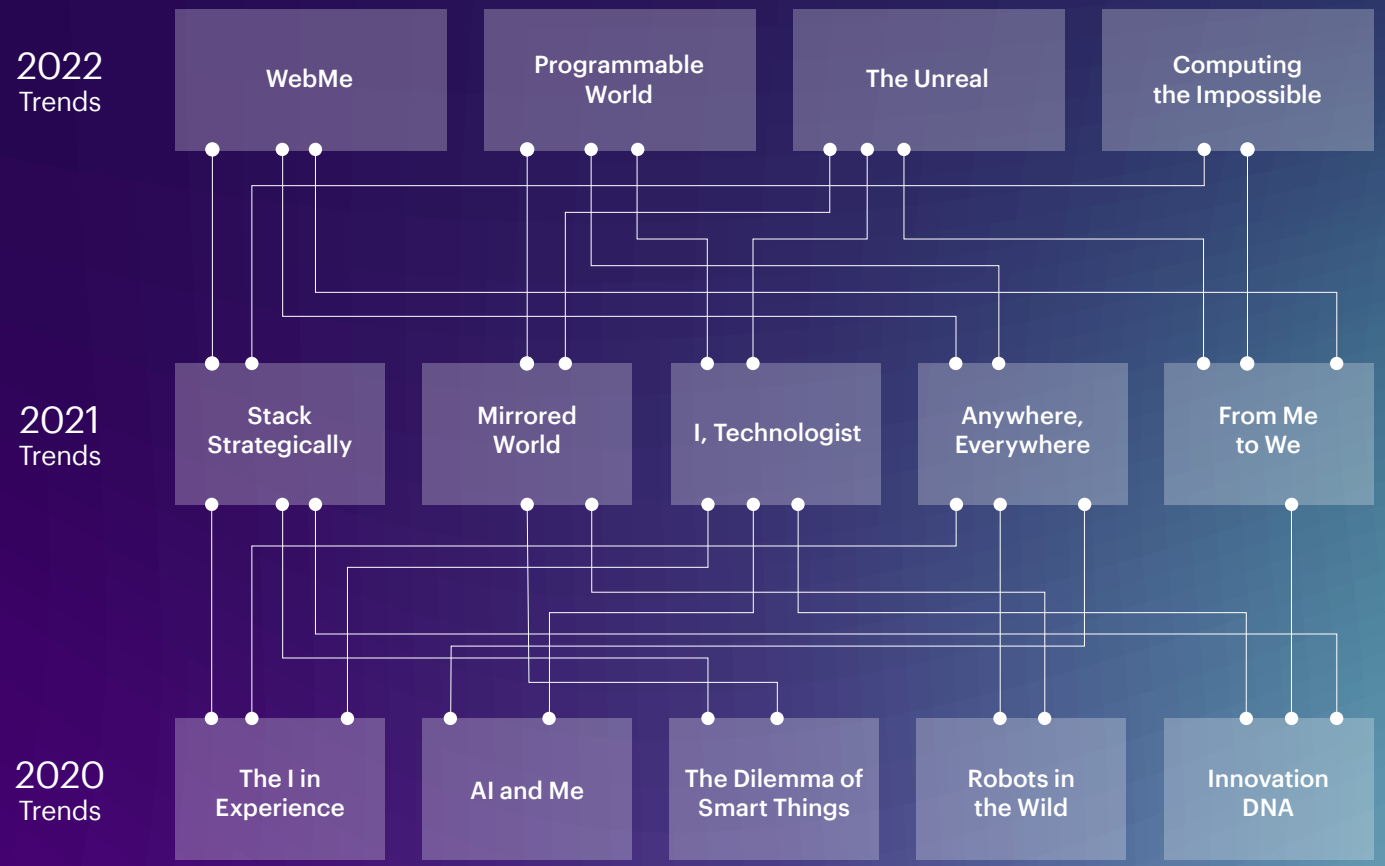
Computing the Impossible

Outlines the outer limit of what is computationally possible as a new class of computing machines emerge with a new curve of compute capability to tackle grand challenges that once seemed insurmountable.

Completing the Picture

Accenture's Digital Health Technology Vision report comprises a three-year set of technology trends, currently including trends from 2020 and 2021.

It's important to recognize that each year's trends are part of a bigger picture. Tracking how they evolve over time offers a glimpse into how they may continue to grow in the future.



Trend 01

WebMe

Putting the Me in Metaverse

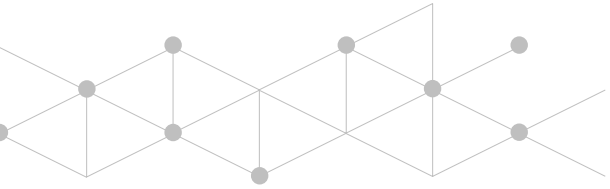
THE FUTURE VIEW

As a doctor checks on his patients in the hospital, he notices one woman is healing very slowly from a simple laparoscopic surgery. The clinician takes his concern to the metaverse, going back in time to witness a previous abdominal surgery this patient underwent. He pulls up this surgical video to show the patient and they both see that the area that is healing slowly had developed scar tissue from this former surgery. A week later after discharge, the patient seamlessly carries her personal health data to a physical therapist who demonstrates exercises in an immersive environment simulating a tropical beach setting. At the end of the session, the therapist fast forwards to the future to show the patient how she will be moving six weeks from today. This is the future of the healthcare metaverse.

THE BIG PICTURE

The internet is being reimagined, and healthcare enterprises need to be ready for what comes next

We have long discussed the blurring of physical and digital worlds, but now the digital world has a new dimension of interactivity. Metaverse and Web3 innovations (see sidebar) are transforming the underpinning and operation of the virtual world. Instead of the internet as a disparate collection of sites and apps, the metaverse is a 3D environment in which moving from work to a social platform can be as seamless as walking from one's car right into the doctor's office.



What are Metaverse and Web3?

Internet of Place – A new experience layer

We see the **metaverse** as an evolution of the internet that enables a user to move beyond browsing to inhabiting and/or participating in a persistent shared experience that spans the spectrum of our real world to the fully virtual and in between.

Internet of Ownership – A new distributed data layer

While **Web3** is an evolving term, in this report we use it to refer to the emerging initiatives that are using technologies such as blockchain and tokenization to build a more distributed data layer into the internet where data can be owned, validated and authenticated by the individuals and items who are represented by the record.

Internet of Place – A new experience layer

Although the metaverse offers an exciting new world to explore, it's not just a place for gaming or entertainment. More than 80% of healthcare leaders see the metaverse having a positive impact on the future (see Figure 1). In the metaverse, we can transcend time and space to simulate interactions, shorten learning cycles and practice procedures, such as in surgical training. We can create distinct experiences for patients that replicate the physical world but remove its constraints. We can help healthcare employees build empathy around the human experience of people aging or of people with historically underserved needs by virtually living in other people's shoes.[3]

Microsoft Mesh, for example, allows users to share experiences from anywhere, on any device, through mixed reality applications.[4]

Such technologies can be used to train clinicians more robustly, to enable more life-like virtual therapeutics and to empower patients to manage their health and perform self-care—that's just to name a few use cases.[5]

Torbay and South Devon NHS Foundation Trust are piloting Microsoft HoloLens 2 and Dynamics 365 Remote Assist in the Breast Care Unit where specialist nurses send real-time video feeds to consultants to get immediate advice on a patient's needs. Consultants can add digital markers and annotations to the videos to guide nurses.[6]

Internet of Ownership – A new distributed data layer

Underpinning this new experience layer is a new distributed data layer. Web3 provides additional texture to this new world by introducing a data framework that generates provenance, veracity and value. By creating a new distributed layer to the internet, individual users have a more intelligent and connected web experience where they can share digital assets, and trade or sell their data based on clear ownership rights and authenticity. The underlying data framework is what supports a range of capabilities from "owning" a pair of digital shoes to authenticating identity and more, while remaining secure.

Though today's solutions may sometimes seem too futuristic, niche or disjointed, they are broader signals of the next digital revolution appearing on the horizon.

Building a responsible metaverse

Interestingly, while the metaverse can re-represent the existing world, we are still the same people living in it. However, a word of caution is necessary. Just as early innovation in this space can carry outsized value, it can carry outsized risks as well. Aside from security risks that must be managed, there are equity risks. Those who cannot see, cannot see. Those who cannot hear, cannot hear. Those who do not have digital health access today may experience a widening gap. The exciting part of this new realm is that we can set up new guardrails that are impossible in the physical world.

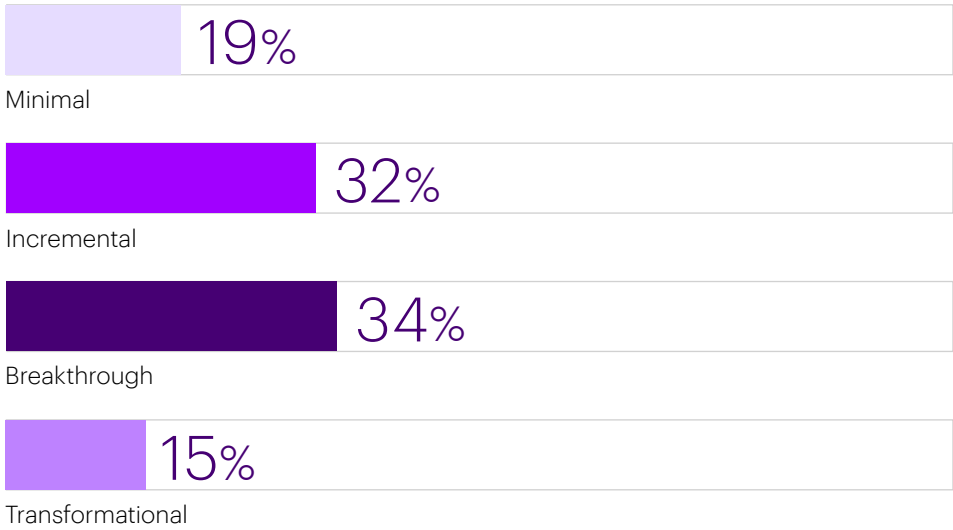
We can use technology to bridge the gap between people's limitations. For instance, what if we could create a world in which a blind person could walk around safely, without obstacles? As we build this metaverse over the next 10 years, we must think about responsible and equitable design of these layers because the actions and choices we make today will set the standards for all that follow.

Leaders are not just pioneering a new digital future for human and enterprise interaction, and many of the rules remain undefined. It is critical that enterprises take proactive steps to proactively shape the "Responsible Metaverse."

> Bottom line: The metaverse needs to be accessible for all kinds of people, regardless of their sensing capabilities, access to technology and beyond.

Figure 1. Most healthcare executives believe the metaverse will have a positive impact.

What level of positive impact do you believe metaverse will have in the future?



Source: Accenture Digital Health Technology Vision 2022, Health sample N=391

THE ANALYSIS

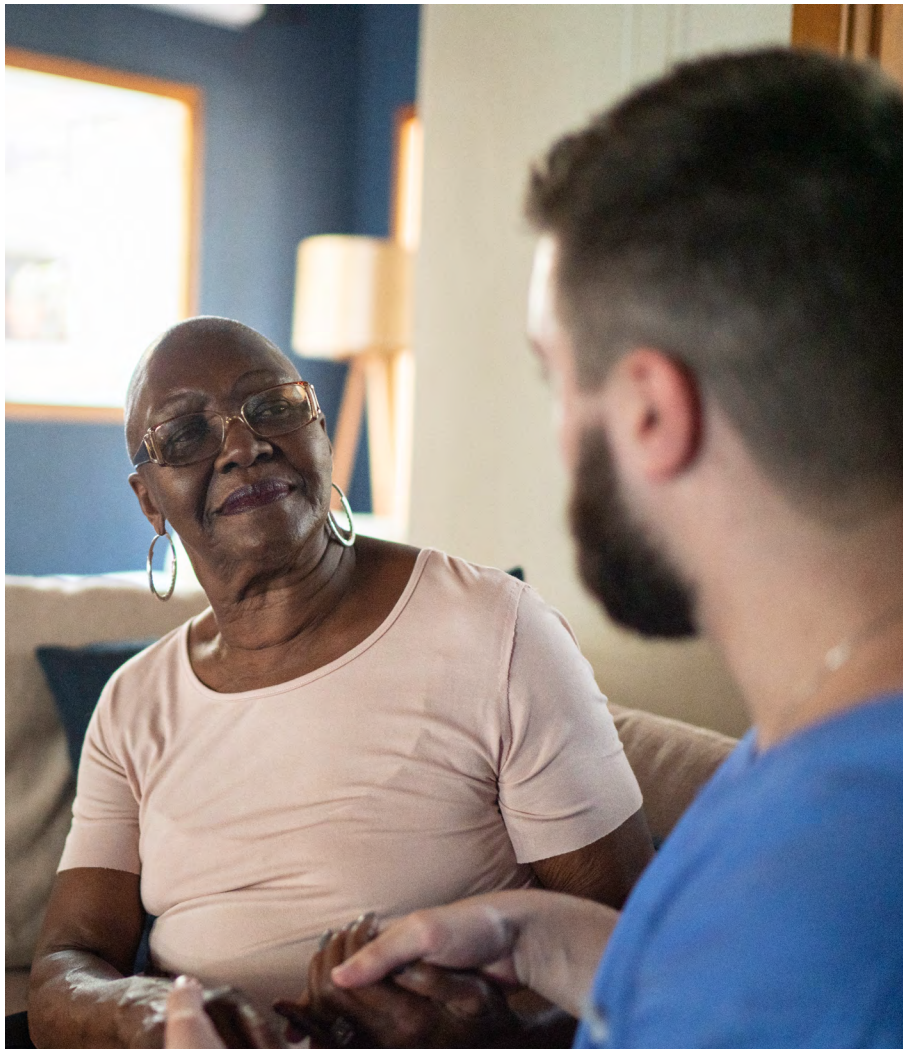
Converging on Our Digital Healthcare Future

We can think about these evolutions as taking place on two fronts: The metaverse as a re-platforming of digital experiences to provide boundless places where people can meet and interact and Web3 as reinventing how data can be owned by individuals and moves through that system.

For healthcare executives hoping to join the ranks of those that shape the next internet revolution, it starts with taking steps to understand these evolutions. What will be the future form and function of the web, are people ready for these shifts and how can the healthcare organization apply breakthroughs starting today?

The last time the internet went through a shift of this magnitude, companies like Amazon, Netflix and Google went from being e-bookstores and renting DVDs by mail to becoming nearly synonymous with the internet itself. Healthcare leaders need to ask – are you setting yourself up today to be the next Blockbuster or the next Amazon?

While metaverse solutions create more realistic and diverse 3D worlds to enter, Web3 changes the way we treat and verify data – creating an undercurrent of provenance, veracity and value that brings gravity to boundlessly creative spaces like the metaverse.



81%

of healthcare executives say the metaverse will have a positive impact on their organizations, with nearly half believing it will be breakthrough or transformational.

Founded by World Wide Web inventor Tim Berners-Lee, Inrupt is one of many companies working toward Web3. By associating data with the individual rather than the platform, it seeks to let people consistently carry their information with them around the digital world. In late 2020, Inrupt released an enterprise version of Solid, a technology built on existing web standards, which lets users control their data and store it in Personal Online Data Stores, or Pods.[7,8] Now, large organizations and governments can build websites or applications that interact with the Pods and, with people's permission, access the data they need for certain tasks.

The greatest value of both metaverse and Web3 in healthcare will depend on the ways in which the two converge with one another. These combined forces have the power to eliminate the distrust, friction and fragmentation patients and healthcare workers experience as they cross platforms, care settings and work environments. The virtual care and office experiences that we've seen accelerate over the past two years can become more "real." But healthcare, perhaps more than any other industry, needs an underlying data foundation that guarantees trust, safety and optionality for all involved.

Accenture Health has been putting a toe into the metaverse waters through our annual HealthTech Innovation Challenge that brings together partners from across the health ecosystem to connect, collaborate, innovate and scale better healthcare experiences for all. The event takes place in a virtual space (Microsoft's Altspace VR and Teams) where people have a clear presence and can walk into a room, chat with other innovators and even play a game of basketball.

THINGS TO LOOK OUT FOR

Pressing Forward without Turning Back

Shifts in the digital world over the past 18 months have made it clear that a "wait and see" approach will before long become "look, it already happened." Especially in the face of a global pandemic, healthcare moved faster than ever, jumping into the digital realm. But how does the industry continue to step forward when the ground beneath us is changing?

The metaverse presents a variety of potential challenges—from providing equitable access to technology to keeping patient data secure to ensuring the safety of patients as they explore care in new realms on their own terms and on their own time. As we enter this new era, it will be critical to have the right governance in place to ensure that enthusiasm for the potential on the horizon should not come at the expense of caution and care for the human at the center of the experience.

Leaders also need to address health equity and accessibility issues and balance virtual and real-life needs. Research from Accenture and HIMSS Market Insights reveals that **93% of US healthcare executives believe that health equity initiatives are important and 89% agree that such initiatives are part of their core business strategy.** Applying new thinking in the metaverse must include tackling top health equity priorities such as reducing health outcome disparities among patient populations, understanding social determinants of health, and improving the attitude, behavior, biases and approach of providers and support staff.

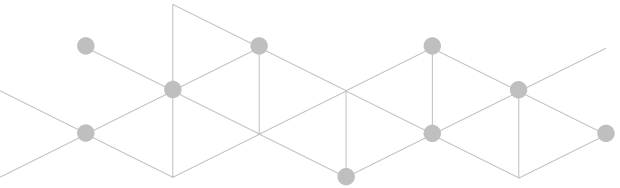
An ill-constructed healthcare metaverse that pays less attention to the fundamentals of access to the technology and what makes people healthy could result in the contrary of its intent – wider digital health inequity and poorer health for people.

ACTIONS TO TAKE

Leading Tomorrow's Internet

It's one thing to understand the urgency and opportunity of this moment, and quite another thing to be prepared and committed to act on it. We recommend time to step back and look at the "should we?" and not just the "could we?"

These are areas that healthcare leaders should focus on to be ready:



Strategy

Healthcare leaders can start building new strategies today, exploring the potential of new products and services and training their people on the technologies that will soon be foundational. Healthcare strategies need to consider how location-agnostic care, user-owned data and blurred boundaries between physical and digital will be incorporated into long-term planning.

Technology

If we want to represent the real world in a digital way, we need the foundational social, mobile, analytics and cloud technologies—and data—to build that world. This is not just about EMR data, it's the full spectrum of data that represents people, physical items and activity. Many healthcare organizations do not have a way to capture data about people and processes. In the metaverse, it will be essential to have the understanding and capacity to collect and use varieties of data. Also, those pursuing the opportunities of Web3 will need the compute power of cloud platforms like Microsoft Azure that can support a variety of programming languages, tools and frameworks. These moves can position healthcare companies to shape new digital worlds with speed and at optimal cost.[9]

Skills

Healthcare leaders can start identifying – and working toward – the metaverse and Web3 skills and capabilities they will need. Creating metaverse experiences may require 3D artists, game designers and experts on the platforms on which they plan to build.

Conclusion

Today's efforts around metaverse and Web3 are creating the next version of the internet. These two momentous technology shifts are simultaneously working to eliminate the friction and distrust that exists between today's many digital platforms and to reinvent digital experiences and how data is owned, moves and is used across those experiences. And in the process, they are changing the future of care delivery, financing and ways of working in the enterprise by forming new means of interaction between healthcare providers, payers and patients.

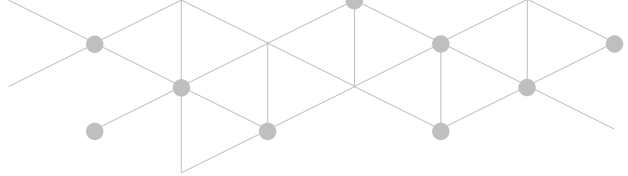
Trend 02

Programmable World

Our Planet, Personalized

THE FUTURE VIEW

Imagine a visually impaired patient has a kidney transplant. The organ has been 3D printed to be compatible with the patient's genetic composition. As the patient recovers, everything about the hospital room adapts to the person: Furniture in the room "talks" so that the patient can safely navigate his way to the restroom. The music automatically adjusts to the patient's mood and the bed position moves at scheduled intervals to reduce risk of bed sores. As he recovers, the organ transmits regular updates to the clinician about electrolyte balance and white blood cell count so that interventions can occur immediately, if needed. Welcome to the programmable world.



THE BIG PICTURE

While the metaverse is all about leveraging the immersive experience of the *virtual* world, the programmable world is about building the next version of the *physical* world in healthcare

Throughout history, major revolutions have occurred when technology fills the world and transforms our relationship with it, giving us more command and control over our environment. And just as our physical world changes, so does what we do in it. We go from gatherers to farmers; from stable hands to machinists; from country-dwellers to urbanites. Healthcare-built environments have also evolved with these physical world changes.[10]

Now, as the real-world impact of the current digital revolution begins to hit critical mass, we are embarking on the next major transformation: The programmable world. In this world, control, customization and automation will be enmeshed in the environment around us. People will have unprecedented ability to command the world to meet their individual needs, deciding what they see, interact with and experience with greater ease and fidelity than ever before.

Healthcare enterprises will build and deliver these experiences, as well as reinvent their own operations, for a new kind of world in which we can make physical spaces adaptable to cues or our needs while improving environmental sustainability.

94%

of healthcare executives agree that leading organizations will push the boundaries of the virtual world to make it more real, increasing the need for persistence and seamless navigation between the digital and physical worlds.

Johnson Controls is using digital tools to enhance patient safety and improve outcomes. When codes are called, digital controls in each patient room are adjusted instantly to help speed response. During a medical event, the company's OpenBlue Code Blue Optimization uses AI to prep the room based on the configuration selected. One button launches features such as alerting clinicians and directing them to the correct patient room, adjusting room temperature and lights, powering off media devices and setting the patient bed to an optimal height.[11] Consider what could come next as digital controls might be programmed to provide direct care through robots or automatically sanitize tools after a procedure.

When digital capabilities are woven into the very fabric of the world, the physical world becomes as smart, customizable and *programmable* as we expect the digital one to be. Once people can frictionlessly interact with their environment, this can transform healthcare as clinicians and healthcare workers will be able to interact with people in new ways across physical and virtual realms while improving environmental sustainability.

Technologies inside the programmable world

5G is the next-generation cellular standard after 4G, which offers ultra-high-speed internet, low latency and high device connection density.

Internet of things (IoT) includes physical objects with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the internet or other communications networks.

Smart materials can sense and respond to changes in their environment. These materials can either have "baked in" intelligence, thereby not requiring external computational systems to react, or they can be connected to or controlled by computational systems or direct command.

Ambient computing uses interconnected IoT devices to integrate computing into people's lived environments and turn the world into a seamless interaction layer.

Augmented reality (AR) is a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

THE ANALYSIS

The Three Layers of the Programmable World

Though our attention for the past years has been fixed on digital transformation in healthcare, the advancement of real-world tech hasn't slowed down. We're starting to shift from bringing digital experiences into the physical world to creating physical environments and experiences that innately are digital. To meet our new expectations for digital conveniences and environmental sustainability, healthcare enterprises will need a deep understanding of three layers that comprise the programmable world: the connected, the experiential and the material.

Connected

Many healthcare enterprises are already investing in and deploying **the first layer of programmable world technology, creating a connected foundation.** For instance, 80% of the healthcare executives we surveyed say the number of IoT/edge devices deployed in their organization has "significantly" or "exponentially" increased in the past three years. The COVID-19 pandemic led to a surge of digital innovation to help providers safely deliver care to people virtually. Now the virtual world is a more comfortable space for people to receive and deliver care—and they are ready to delve in further.

Change has begun. Smart beds are being used to monitor patients' breathing, temperature, pulse and other vitals through sensor chips. Data is transferred to devices for clinicians to act on. Baystate Medical Center is minimizing hospital-acquired pressure injuries (bed sores), which affect more than 2.5 million patients in US acute-care facilities each year.[12] Smart bed technology is helping providers at Baystate Medical Center to address moisture exposure caused by incontinence. The system detects moisture and alerts nursing staff so they can quickly and discreetly address the issue, helping patients to maintain their dignity while also keeping them safe. Ninety percent of Baystate's nurses and patient care technicians surveyed said the system improved their ability to do their jobs.[13]

Experiential

The next layer of the programmable world is experiential. It has the ability to sense and change its own characteristics. Building on data collected by IoT and edge devices and processed at 5G speeds, digital twins are a core constituent of this layer. These digital models of the physical world give healthcare organizations real-time insight into their environments and operations and can transform people's healthcare experiences in them.

Another noteworthy component of the experiential layer is augmented reality (AR). Heru uses an AR headset to detect contrast sensitivities, color vision deficiencies, visual field defects and other vision disorders. Results are available immediately via web portal or added to a patient's EMR.[14]

Surgeons and doctors at Imperial College Healthcare in London used mixed reality headset Microsoft's HoloLens AR to round on COVID-19 patients in the thick of the pandemic. One clinician would round while others could join in virtually. Early research showed that using HoloLens reduced staff time in coronavirus wards up to 83%.[15] In some NHS facilities, patients are even being discharged to "virtual wards" where patients are given a pulse oximeter and remote monitoring devices so they can be monitored daily from afar.[16]

80%

of healthcare executives report the number of IoT/edge devices deployed in their organizations *significantly* or *exponentially* increased over the past three years.

Material

The final layer of the programmable world is material and constitutes how things are made. It includes a new generation of digital manufacturing and smart materials, which will bring programmability into the physical aspects of our environments. Advances in digital manufacturing techniques are changing how and where physical goods can be made, making on-demand and hyper-customized products a reality in healthcare.

For instance, 3D printers are making molds, medical devices, prostheses and even surgical tools, such as the endoCupcut—a 3D-printed surgical tool used for hip cup replacements.[17] Some healthcare organizations are using modular building blocks for new hospital construction. Design firm Blox digitally designs hospitals and manufactures the pieces that can then be put together to form an up-and-running facility in a matter of months.[18]

But being able to produce custom devices, tools, prostheses and tissues on demand is only half of this material layer. New kinds of smart materials and programmable matter will soon make it possible to customize or enable custom experiences with physical products after production as well.

Today, it is smart materials like **Nanowear's SimpleSense** which is an FDA-cleared, non-invasive undergarment which monitors multiple patient vitals such as heart rate and sounds, respiration rate, lung volume and physical activity to analyze the data to predict risk of heart failure or lung disease, among other ailments.[19]

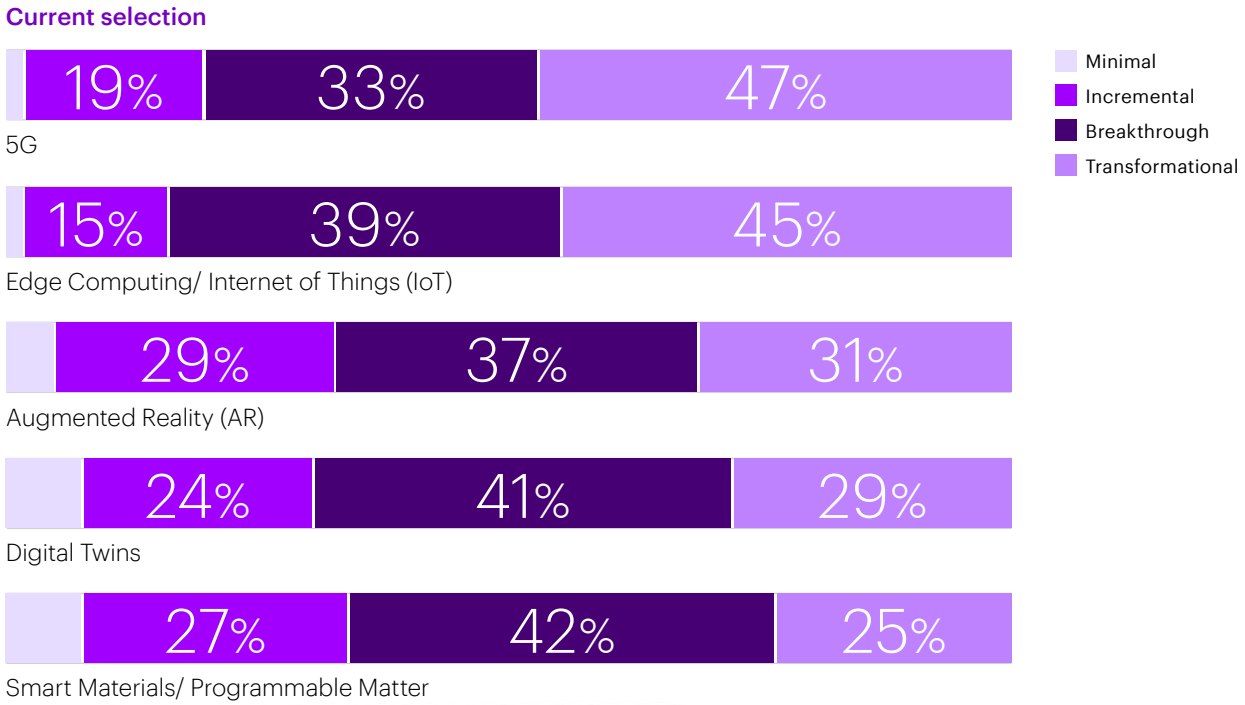
Tomorrow, it is smart material that's strong, soft and as conductive as many metals, like those being developed at Rice University. The smart material contains carbon nanotube threads which can be sewn into clothing without concern about damage from washing, stretching or sweat. These carbon nanotube threads work just like the wires in an EKG device, which helps detect heart conditions by measuring heart rhythms which can be used for health and healthcare applications.[20]

The connected, experiential and material layers of the programmable world will enable new ways to augment, customize, automate, alter and otherwise "program" our physical environments for health and healthcare applications—and they will introduce an entirely new competitive landscape for the healthcare industry.

Ten years from now, we can expect to see the programmable world offer new opportunities for healthcare payers and providers to blend their services for further differentiation and better service. Imagine a hospital that is customized to patient needs. Walls that adjust to influence mood, with real-time directions for both patients and clinicians to optimize the use of space and devices. Rooms could adjust temperature, air quality or provide clinical decision support in real time. Patients could have available prosthetics that combine 3D printing, plus personalized medicine and machine learning, to evolve with the patient body. The organizations that bring this technology to their workers' and customers' built and lived environments will be the ones to shape the next generation of healthcare.

Figure 2. Healthcare executives see positive potential impact from emerging technologies.

What level of positive impact do you believe the following technologies will have on your organization in the future?



Source: Accenture Digital Health Technology Vision 2022, Health sample N=391

THINGS TO LOOK OUT FOR

Challenges Connecting the Programmable World

The seamless combination of different capabilities is what will bring customization, automation and more out of digital screens and into our physical world. As seen in Figure 2, healthcare executives believe emerging programmable world technologies will have a positive impact in the future. For instance, AR gives us new ways to interact with information, in the context of our physical environment, which is often supplied by IoT devices and digital twins, and networks of various connected devices can share information to autonomously trigger changes in people's environments. But there are significant challenges to connecting these technologies safely and at scale—data interoperability and cyber security.

Most healthcare organizations aren't going to develop these technologies in-house, so access to and interoperability between different companies' products will be key. Also, as the healthcare industry scales up programmable world projects, it will be introducing many more connected, intelligent devices which create new entry points connecting our physical and digital worlds. Each of these entry points opens possibilities for innovation and new kinds of patient experiences, but each also creates potential risk. Significantly, risks to cyber security and data privacy will not be relegated to the digital world, but will have serious consequences in the physical world, too.

ACTIONS TO TAKE

Full Stack Programmability

Beyond the fundamentals of data interoperability across digital and physical environments, becoming a healthcare leader in the programmable world will require exploration, experimentation and development across all three layers. It's time to start working toward "full stack" programmability.

Level up the foundational, connected layer

5G is poised to be transformational in terms of its speed and low latency, but rollouts are still in the works. By the end of 2021, Ericsson estimated that 5G networks would cover only about 25% of the global population, and according to a 2020 Qualcomm study, the wide range of 5G use cases are not expected to be fully realized until 2035.[21,22] Some health systems are starting to level up their foundational connected layer like **Emory Healthcare through a 5G collaboration with Verizon** and **Rush University Medical Center through a 5G collaboration with AT&T.**

Get involved with industry-wide alliances

To have trustworthy data, healthcare organizations need the right channel, source, policies and governance in place. Many have one or two pieces of the puzzle but are missing the other crucial pieces. Join in consortiums and industry standards groups to shape governance, data interoperability and cyber security standards. From an interoperability perspective, this could mean participating in ecosystem-wide efforts to set standards for how devices connect and communicate in healthcare.

Bridge digital and physical worlds in the experiential layer by building digital twins

Even without the full maturity of the programmable world, these platforms already provide significant operational and competitive advantages. And over time, digital twins will become the engine for every healthcare enterprise's programmable world strategy, letting them invent products, design experiences and run their organizations in ways that would have been unimaginable years ago.

Explore future technologies on the material layer

Partnerships with startups and universities are a good way to make certain you are staying right at the forefront of real-world technology innovation. As this space is still budding, it is critical that leaders test and learn new material layer technologies like 3D printing and smart materials and revise the way they consider return on investment, and what key performance indicators look like.

Conclusion

We're about to live in environments that can physically transform on command, that can be customized and controlled to an unprecedented degree, and that can change faster and more often than we have ever seen before. With these environments, a new arena for innovation and healthcare competition will be born. Will you be ready?

Trend 03

The Unreal

Making Synthetic, Authentic

THE FUTURE VIEW

Consider if a new COVID-19 variant were to emerge. Clinicians use synthetic data to create artificial health records that replicate patient health history, vitals, chronic conditions and other factors to determine the likeliness of certain groups to contract the variant. They also simulate how it might spread. Soon after, bad actors infiltrate the synthetic records, populating them with false data that undermines the hard work of the clinicians. Deepfakes spread synthetic content on social media that says certain populations are at risk when, in fact, they are not. Fear is escalated, safety measures aren't taken in the right places. These are the potential good and bad possibilities of the unreal world.

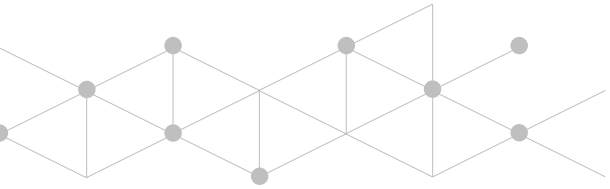
THE BIG PICTURE

We are entering a world of synthetic realness, where AI-generated data convincingly reflects the physical world

In this world of synthetic data, images and chatbots, spoofing and fakes, we face questions: What's real, what's not and perhaps more importantly, when do we care?

Synthetic realness can push AI to new heights in healthcare. Synthetic data can represent patient datasets for use in research, training or other applications.

Right now, regulations like HIPAA protect health information such as diagnostic imaging, genetic data, medical histories, diagnoses and more making it difficult to use patient data and run scenarios, especially across organizational boundaries.



Unpacking the unreal

Generative AI – Artificial intelligence that uses unsupervised learning algorithms to create new digital images, video, audio, text or code.

Synthetic content – Digitally generated text files, images, audio recordings and videos using generative AI technologies to simulate real content. It also includes "deepfake" images or recordings of a person in which their face or body has been digitally altered so that they appear to be someone else, typically used maliciously or to spread false information.

Synthetic data – Artificially generated data from computer simulations or algorithms that mimics real-life data stored in tables.

Blockchain – A system of recording information in a way that makes it difficult or impossible to change, hack or cheat the system.

Distributed ledger technology – The technological infrastructure and protocols that allows simultaneous access, validation and record updating in an absolute manner across a network that's spread across multiple entities or locations.

94%

of healthcare executives agree that their organizations are committed to authenticating the origin of their data and genuine use of AI.

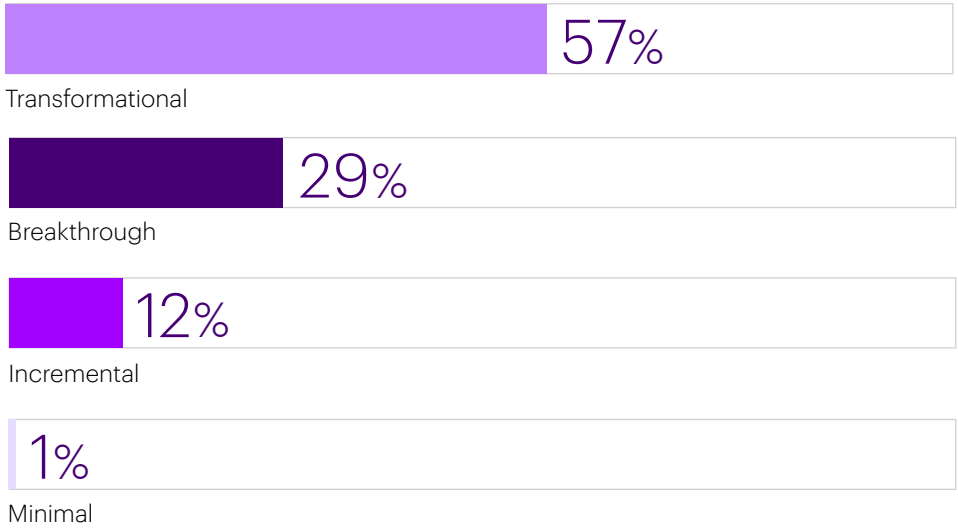
Synthetic content, such as AI-generated text, video and audio, could be used to counter malicious deepfakes and misinformation in healthcare by spreading truth from trusted sources to counter damage bad actors. Indiscernible fakes exist, so as synthetic realness progresses, we must focus on authenticity. We'll begin to evaluate "Is this authentic?" based on four primary tenets:

- Provenance – what is its history?
- Policy – what are its restrictions?
- People – who is responsible?
- Purpose – what is it trying to do?

That said, using these technologies pushes healthcare into controversial terrain. It raises tough questions about how to use generative AI in an authentic way within the context of bad actors using these same technologies to create deepfakes and disinformation that undermine trust. It's time to ready the healthcare enterprise – because the unreal world is about to get real.

Figure 3. AI is overall seen as having a positive impact on healthcare organizations.

What level of positive impact do you believe artificial intelligence will have on your organization in the future?



Source: Accenture Digital Health Technology Vision 2022, Health sample N=391

THE ANALYSIS

The Rise of the Unreal World

Healthcare enterprises are becoming architects of the unreal world. First, synthetic data is being used to train AI models in ways that real-world data practically cannot or should not. This realistic (yet unreal) data can be shared, maintaining the same statistical properties while protecting confidentiality and privacy. It can also be made to have increased diversity to counter bias, thus overcoming the pitfalls of real-world data.

For example, in the early days of the pandemic, Israel's largest hospital used a platform created by the Israeli startup MDClone to create synthetic COVID-19 patient data, which could then be shared with academic researchers and other organizations.[23] This allowed them to innovate faster and in ways to create an algorithm that helps clinicians determine when patients should be given drug treatment or sent to the intensive care unit.

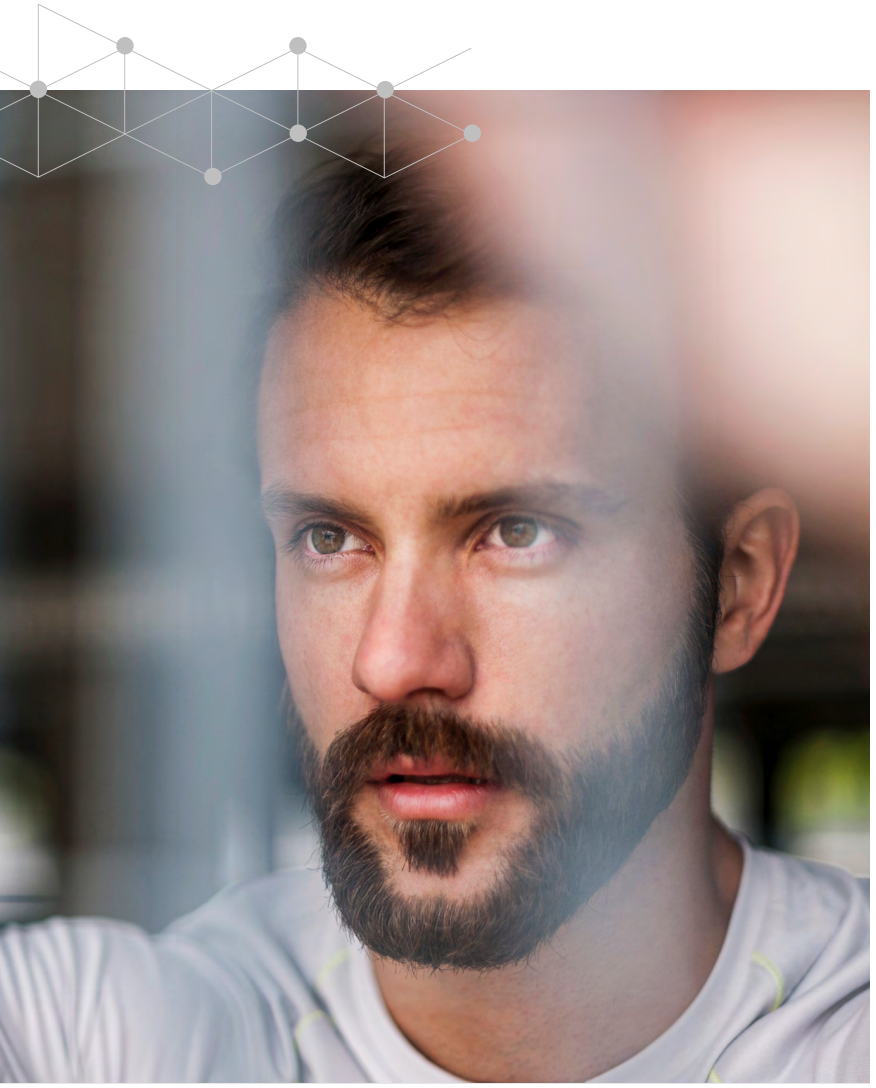
64%

of healthcare executives say IT/security breaches are their primary concern about deepfakes and/or disinformation attacks.

Researchers in Finland are looking at how synthetic imaging data can be used for brain research. Brain structures shown in MRI images are unique and thus impossible to hide a person's identity. Furthermore, the supply of authentic MRI images is limited and use is subject to permit, so artificially created data solves this challenge and accelerates the speed of collecting the necessary volume of data to conduct research. Synthetic brain images also can be used in the diagnostics of Alzheimer's disease or in research projects related to brain cancer.[24]

A second use of synthetic data is to be more human-like for creation and interaction. In people's everyday lives, chatbots and virtual assistants are increasingly common and convenient – and new technologies could make them more realistic than ever. However, while pursuing these technologies in healthcare we must remember: Just because *we can* use AI, doesn't mean *we should*.

Synthetic data, when used properly, can help with training efforts. The University of Florida Health and NVIDIA have created SynGatorTron™, an AI tool that generates synthetic patient data that is used to train the next generation of medical AI systems to understand conversational language and medical terminology.[25] These types of tools will be key contributors to medical chatbots that communicate with patients just as simply as Siri does.



THINGS TO LOOK OUT FOR

Bad Actors in the Unreal World

Currently, the biggest threat for healthcare organizations in the synthetic world are the actors who use it maliciously.

Researchers have found that deep fakes can easily infiltrate medical imagery, such as MRIs, X-ray scans and CT scans. They found that deceptive attackers can easily surpass systems with outdated security to add or remove tumors on imagery. The potential results? False detection of tumors and misdiagnoses that lead to lack of treatment or unnecessary treatment.[26]

These bad actors could also come across as regular citizens sharing information via social media through synthetic content. Carnegie Mellon University's Center for Informed Democracy and Cybersecurity found that bots may account for 45% to 60% of Twitter accounts discussing COVID-19.

Many of those accounts established early in the pandemic propagate medical misinformation, spread false medical advice and promoted conspiracy theories about the origin of the virus.[27]

Deepfakes could have significant negative impact on patient outcomes. If healthcare consumers are duped by synthetic content, they'll blame the healthcare organization – or they won't become patients in the first place. Lives are at stake as are the enterprises' reputations.

ACTIONS TO TAKE

Elevating Authenticity

While synthetic content can sow distrust and discord, it also has the power to improve human relationships.

If designed and deployed in the right ways, AI with human-like qualities can be used to improve people's performance and strengthen their relationships with each other.

Synthetic data can inform AI models to benefit patients. Still, many cases won't be so black and white. In fact, there are ongoing debates about the use of the latest generative AI capabilities—and it's not clear where the new social contract will stand.

Using generative AI in an authentic way means taking heed of **provenance, policy, people and purpose.** By observing these four tenets, healthcare organizations can gain confidence not only in their decisions to trust others, but also in their use of generative AI such that others can trust them.

Provenance

One way to verify the provenance of digital content and identity – thereby demonstrating authenticity – is through use of distributed ledger technology (DLT). No matter what technologies you use, establishing provenance will be critical as your organization increasingly deals with potential deepfakes and disinformation – and enabling others to establish provenance as they interact with your business and content will be just as important, too.

Policy

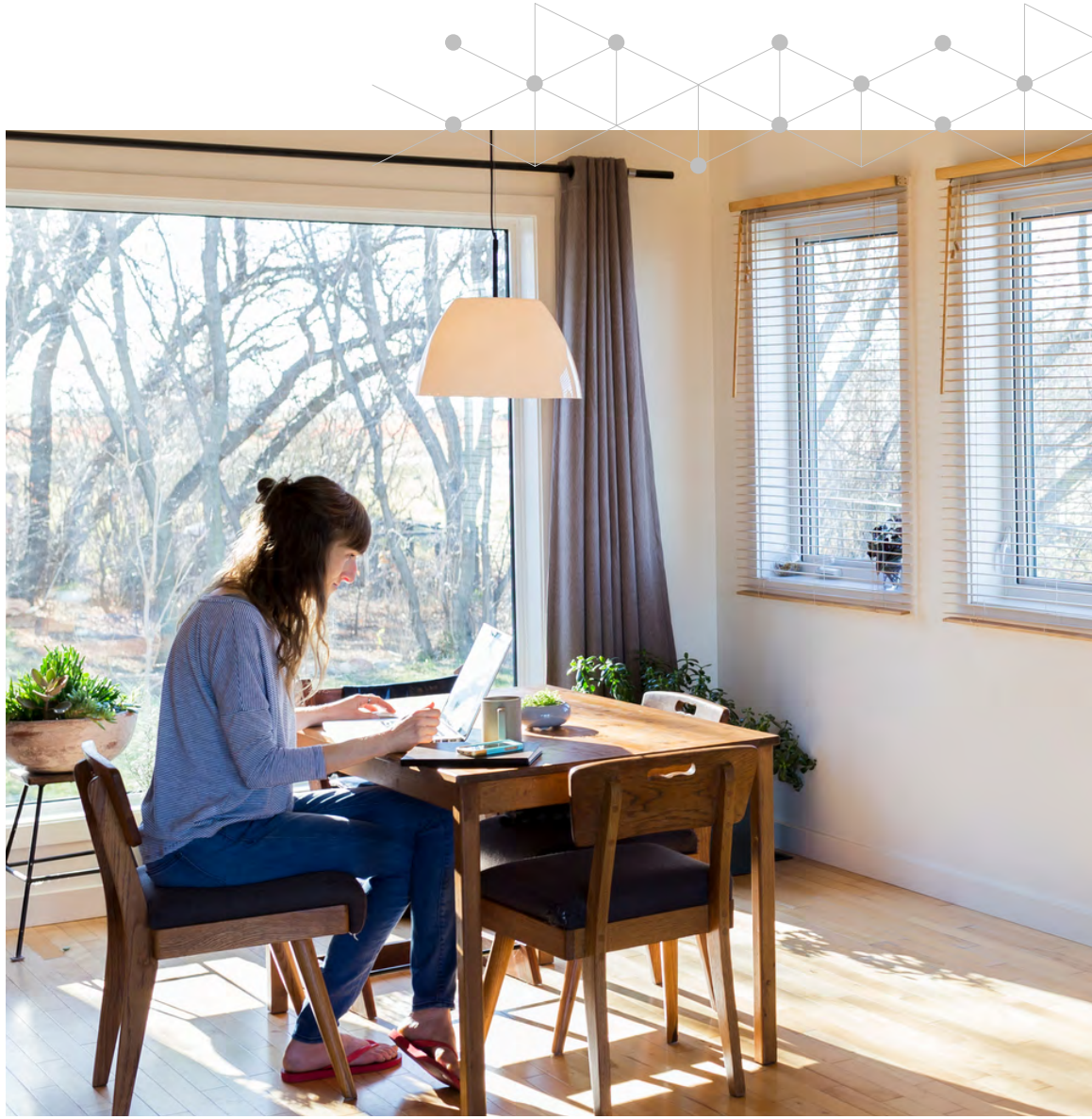
Prepare to deal with the challenges that arise with the use of AI. Take stock of the policies your business must adhere to with respect to generative AI specifically. Much of this space is yet to be defined, so where there isn't guidance, you'll need to define your own policies based on your services, products, customers and most importantly, values.

People

Having these governance structures in place is imperative to handle the inherent risks baked into the unreal world in healthcare. Decide, for example, who is responsible for having these tough conversations and what committees are drafting internal policies? Who will be held accountable if privacy is compromised or patients or members feel duped? Finally, who will be the point person responsible if your organization falls prey to a deepfake or disinformation attack?

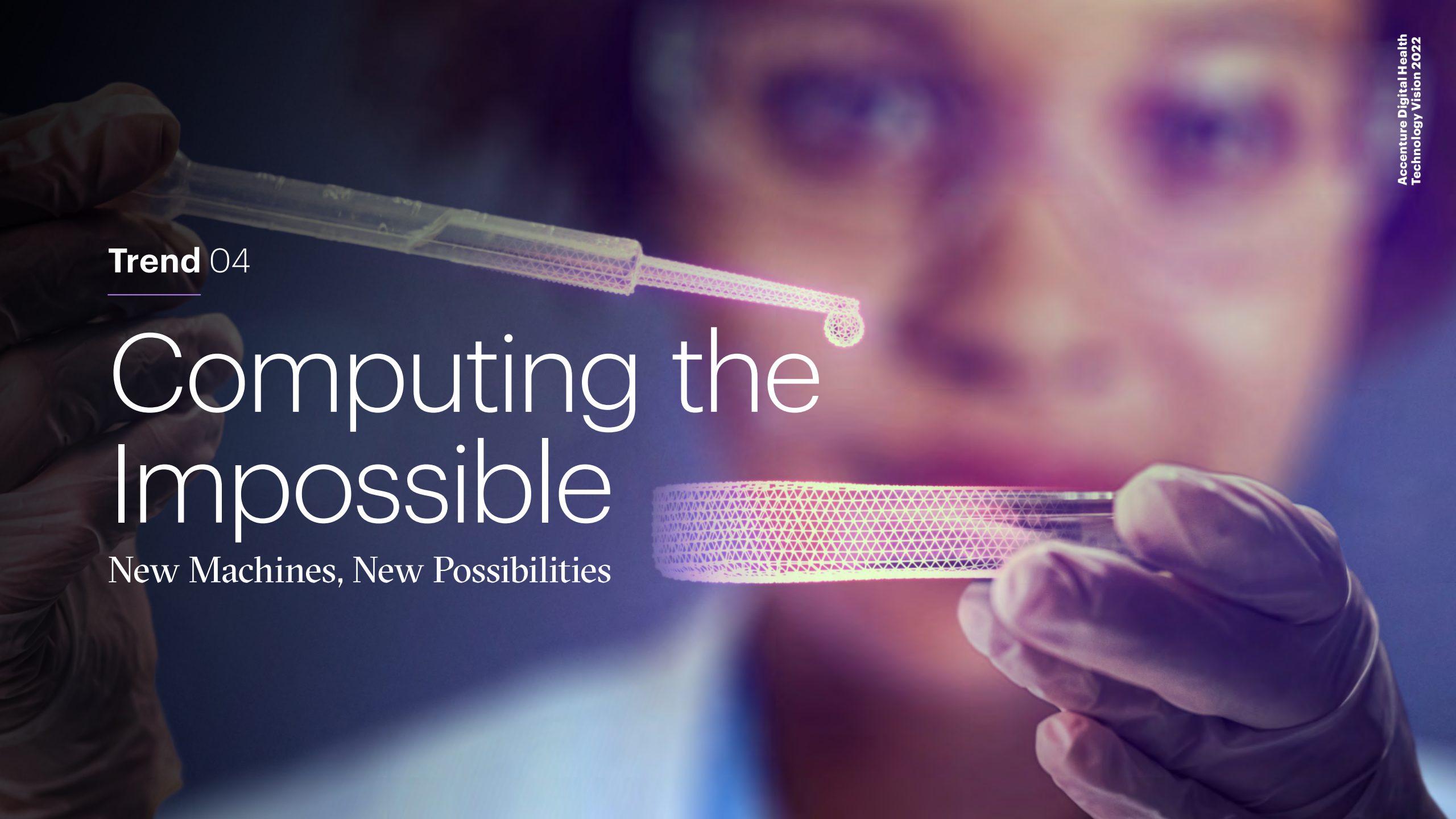
Purpose

Define the purpose behind the use of synthetic data and content. What are the key metrics that can demonstrate the advantage of synthetic over non-synthetic content? For instance, if your organization uses a chatbot simply to cut costs (as opposed to improving availability), there's a good chance it's not living up to its intended purpose of serving people. However, if the purpose of using synthetic data in a model is to insert counter bias, thereby improving the output of the model, then it could be an authentic use of generative AI.



Conclusion

As areas like generative AI progress and models improve, healthcare enterprises are building the unreal world. But whether we use synthetic data and content in ways to improve the world or fall victim to malicious actors is yet to be determined. Most likely, we will land somewhere in the expansive in-between, and that's why elevating authenticity within your healthcare organization is so important. Authenticity is the compass and the framework that will guide use of AI in a genuine way—across industries, use cases and time—by considering provenance, policy, people and purpose. Ultimately, it will unlock new attitudes toward and experiences with AI, unleashing the benefits of the unreal world.



Trend 04

Computing the Impossible

New Machines, New Possibilities

THE FUTURE VIEW

A new strain of cancer has mutated and is now showing up among patients with no family history or biomarkers. Imagine if supercomputers could process billions of clinical records, coupled with synthetic data, to yield insight on disease patterns. The computational models simulate human models so pharmaceutical companies can get ahead of the mutation and develop a new drug formulary. Supercomputing capabilities allow the researchers to model short-term and long-term effects of the drug on patients. Doctors can understand a patient's probably of this strain early and develop a genetically customized treatment plan. Now that's computing the impossible.

THE BIG PICTURE

Since the development of the first algorithm that leveraged the theoretical properties of a quantum computer in 1994, we've made quantum leaps

Today, we are building the machines that can run the complex algorithms created decades ago. Quantum computers can resolve issues simultaneously, thereby multiplying computing capacity. This means that healthcare executives can test different scenarios and find complex dependencies much faster than ever before.

We are witnessing the emergence of a new class of machines which are stretching the boundaries of what computers can do. Problems once thought impossible to solve because they require computing large, complex datasets are now in the realm of the possible. And because industries are in fact *defined* by their most intractable problems, when these machines mature, they will ignite a cascade of disruption that will revolutionize industries, including healthcare.

75%

of global healthcare executives report quantum computing will have a breakthrough or transformational impact on their organizations in the future.

Healthcare has several intractable problems that quantum computing could help solve by making sense of vast amounts of data. For instance, what if data could help us to better treat diseases or predict outbreaks of viruses? **HumMod** is a mathematical model of human physiology that includes thousands of variables such as body fluids, circulation, hormones, metabolism and temperature. Researchers could use this "virtual human" to test clinical trials, develop medicines or predict regions likely to be susceptible to outbreak.

What if payers could use quantum computing to better predict health risk and/or reduce fraud, waste and abuse in real time? For fraud, waste and abuse, payers would be able to validate that providers are practicing within medical and business policies and that the procedures and drugs prescribed were received by their members. Additionally, pattern recognition would enable identification of frequent offenders at the provider level and enable payers to rapidly understand the likelihood of fraud at the time of claim submission. This could reduce abusive prescribing practices, which cost Medicare insurers up to $300M each year.[28]

Of the healthcare executives we surveyed, 96% say their organization's long-term success will depend on next-generation computing to solve the seemingly unsolvable problems not addressable by classical computing.

Three sets of new computing machines are emerging: high-performance computers (HPCs), bio-inspired and quantum. Quantum is the pinnacle of next-generation problem solving, but HPCs, or massive parallel processing supercomputers, can also help organizations to efficiently take advantage of the swaths of data inherent to the digital world.

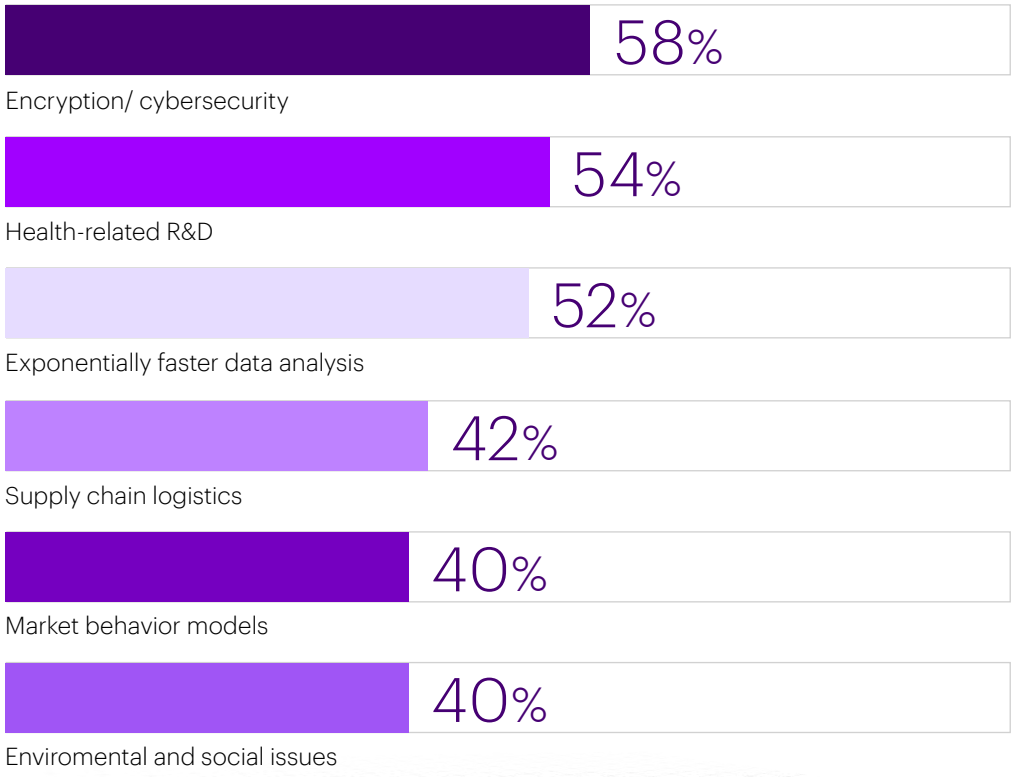
Accenture is investing in quantum in healthcare by way of The Good Chemistry Company platform, which combines cloud, AI and quantum computing in an integrated platform designed for developers. The platform's engine enables faster, more accurate and scalable ways to simulate chemistry, which can accelerate pharmaceutical drug discovery.[29]

And biology-inspired compute is a new class of capabilities that draws inspiration from or relies directly on natural biological processes to store data, solve problems or model complex systems in fundamentally different ways.

These three sets of machines will dramatically reduce the difficulty of solving some of the world's deepest challenges, inside and outside of healthcare.

Figure 4. Healthcare organizations plan to compute the impossible in a variety of ways.

For which of the following would your organization use next-generation computing?



Source: Accenture Digital Health Technology Vision 2022, Health sample N=391

THE ANALYSIS

Compute for a New Era of Enterprise

More and more data are being created and collected every day, and post-digital healthcare organizations want to use the insights that come from it – thus driving demands for greater computing capabilities. To illustrate, IDC found that in 2020, 64.2ZB of data was created, captured or replicated, and that number is expected to grow to 180ZB by 2025.[30] But of all the data created in 2020, only 10.6% was useful for analysis or for AI/ML models, and only about 44% of that was used – meaning currently, businesses are underutilizing their data and losing value.[31]

High-performance computing

Increasingly the answer to this massive data conundrum is found in HPC, or supercomputing. A combination of graphics processing units (GPUs), application-specific integrated circuits (ASICs) and other purpose-built chips are starting to push HPC capabilities to new thresholds and benchmarks previously thought to be decades away – an acceleration that is rapidly making these capabilities mission-critical for healthcare organizations everywhere.

One of the most computationally intensive data operations on record was recently achieved by taking advantage of the sheer volume of latent compute power that exists in our everyday devices. Folding@Home (F@H) began as a small, distributed computing project designed to let volunteers dedicate portions of unused processing power to run protein folding simulations.[32]

Protein folding is a necessary component to designing drugs and vaccines. The challenge is that proteins can fold themselves into countless possibilities and shapes, and designing a drug therefore requires a computationally difficult level of simulation, or expensive trial and error. Since its inception, F@H participants waxed and waned, generally hosting around 30,000 nodes at any given time. But suddenly, in March 2020, F@H's install base jumped to over 400,000 independent machines, adding the horsepower that allowed F@H to effectively simulate and "map" the structure of the Sars-Cov-2 virus.[33] In the process, F@H became the first project to break the exascale threshold – defined as a computational system capable of 1018 floating point operations per second.[34]

Bio-inspired compute

While HPC may be more familiar, there's another class of technology reshaping what enterprises can do. Biology-inspired compute takes advantage of the most mature systems in the world: nature. There are two subdivisions to this class: biomimicry, or systems that draw inspiration from biological processes, and bio-compute, which are systems that directly utilize biological processes to perform computational functions.

Biomimicry has been used in areas ranging from chip architectures to learning algorithms, and successful pilots have shown this emergent field can deliver benefits like greater power efficiency, speed and accuracy in more complex problems. For instance, one technology at the forefront of biomimicry is neuromorphic computing.

Neuromorphic chips, like Intel's Loihi, have introduced a brand-new design to computer chips: they are modelled after the human brain.[35] The chips use artificial neurons to transmit information in a way that is more power-efficient than traditional CPUs.

Also, this architecture is optimized for the execution of spiking neural networks (SSNs), a different approach to neural networks than the artificial neural networks (ANNs) that power today's AI systems.

We also are beginning to see the fusion between biology and machines – where machines don't just mimic biological operations, but directly leverage biological processes. At the forefront of this space is data storage.[36] One estimate predicts DNA could store an exabyte of data in just one cubic centimeter of space, with the potential to persist over 700,000 years based on biological DNA found on earth.[37]

This is new territory in healthcare, but many organizations are beginning to explore it. George Washington University is helping to open the door to bio-compute through the **BioCompute Object Specification Project**, which is an informal community that aims to streamline data and workflow exchange between the FDA, researchers, pharmaceutical companies and bioinformatics technology developers.[38]

A recent research project illustrated that a BioCompute Object (BCO) can capture the data processing workflow and facilitate the submission of analyses to the U.S. Food and Drug Administration (FDA). Researchers used synthetic data to resemble real biological data and then simulated a pharmaceutical regulatory submission to the FDA and subsequent FDA review that included an independent analysis of the submitted data.[39] This project demonstrates how bio-compute could streamline and accelerate the drug approval process.

Quantum computing

HPC and bio-inspired compute won't be the only tools digital healthcare organizations need to execute on their future ambitions, however. While they are immensely powerful, HPC machines are still "just" classical computers, and bio-inspired compute is "just" a new approach to similar problems. The single biggest watershed moment for computing will be when quantum computers solve the healthcare problems that were considered quite literally intractable – making the impossible possible.

Each one of these compute areas – HPC, bio-inspired compute and quantum – contributes to a specific niche, but taken as a whole, a clear trend emerges: We are amid an evolution toward machines that, down to the very physics of their operation, are unlike any in existence today. As they grow, they will expand the window of what's possible in healthcare.

THINGS TO LOOK OUT FOR

Benchmarking and Skills

The problem-solving capabilities enabled by this new wave of computing may lead to the biggest technological disruptions of our time.

Due to the nature of the problems at hand, when breakthroughs are made, adoption is likely to scale up rapidly and to cross-pollinate into other industries just as fast. There are obvious signs to follow to track this trend, namely, benchmarking. But it's just as important for leaders tracking the maturity of these machines to understand exactly how to interpret that information.

Benchmarking

As more machines use customized chips and architecture and are built to purpose, more specific benchmarking may be required to understand true top end performance and capabilities.

Sandbox AQ, a SaaS company that offers quantum computing and IT tools for commercial use, was created six years ago as an independent division of Google. Mount Sinai Health System is collaborating with Sandbox to protect patient data against cyber security threats. The organization's Post-Quantum Cryptography (PQC) solutions will be embedded into Mount Sinai's network to get ahead of threats.[40]

Skills

The impact of these machines will directly follow the emergence of skilled workers who can use them. Expertise in mathematics, physics, engineering and coding will be more important than ever before. Another survey of top-level executives revealed the belief that top factors delaying potential quantum deployments today are a shortage of trained workers as well as software and hardware availability. In that same survey, half of respondents believed that lack of quantum experts is what was stopping quantum from being even more popular.[41]

ACTIONS TO TAKE

Forging Tomorrow's Industries

The computers that will create and fuel the next generation of industry are already being built, and enterprises need to be part of this wave or risk being swept away by it.

Intelligence: Evaluate how these technologies will shape future healthcare operations

What problems are simply considered the cost of doing business? How would it reshape the business if you could start solving those problems? Which class of machines is likely to impact your healthcare enterprise earliest? Those looking to take an active role in shaping the next wave of healthcare should be asking what hardware they can start building or using to be the first to solve their biggest and most impossible problems.

Partner: Forge inroads with others

Partnerships with organizations leading the charge in quantum computing in healthcare from large tech companies, digital natives and beyond are key to experimentation and exploration of future enterprise impacts. For example, the Quantum Leap Healthcare Collaborative is a charitable organization that fuels unique collaborations across the medical, technology and bioscience industries to develop and implement innovative ways to deliver better, less costly healthcare.[42]

Bridging gaps with startups

Outsourcing innovation to a startup can be a powerful way to quickly pivot to meet new healthcare market needs.

When working with startups, it is important to find the ventures that fit well with your company's goals and objectives. In a recent survey of corporate leaders, the MassChallenge accelerator reported that 45% of respondents listed "strategic fit" as the most important factor in determining success with a startup partner.

Consortia: Join forces to pave the way

Consortiums are also converging, committed to the growth and development of these fields. The U.S. National Institute for Standards and Technology launched the Quantum Economic Development Consortium (QED-C), composed of corporations, academic institutions, public health organizations, federally funded laboratories and more.[43,44] The group aims to find use cases, determine technology and workforce gaps, and work with stakeholders to fill those gaps to enable the quantum computing ecosystem, as well as to foster the nascent market.[45,46]

Conclusion

For decades, computers that could efficiently solve the world's "grand challenges" have been nothing more than theoretical concepts. But healthcare enterprises can't afford to think about them in the abstract any longer. They are rapidly improving, and their impact on industries' most fundamental problems and parameters can either be an industry-ending event or the biggest opportunity in generations. Healthcare leaders who start rearchitecting their industry today, anticipating a future with these machines, will have the best shot at the latter.

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About the Technology Vision

For more than 20 years, Accenture has developed the Technology Vision report as a systematic review across the enterprise landscape to identify emerging technology trends that will have the greatest impact on companies, government agencies, and other organizations in the coming years. This year the trends look further out into the future than ever before, while remaining relevant across industries and actionable for businesses today.

Accenture Labs and Accenture Research collaborate on the annual research process, which includes:

- Input from the Technology Vision External Advisory Board, a group of more than two dozen experienced individuals from the public and private sectors, academia, venture capital, and entrepreneurial companies. In addition, the Technology Vision team conducts interviews with technology luminaries and industry experts, as well as many Accenture business leaders from across the organization.
- A global consumer survey to capture insights into the use of, interactions with, and beliefs about technology in people's everyday lives. In addition, Accenture conducts a global survey of C-level executives and directors to understand their perspectives and use of emerging technologies across their organizations.
- Experiential research and data science to analyze technology developments and advancements.

Accenture Research conducted a global survey of 24,000 consumers to capture insights into their use of, interactions with, and beliefs about technology in their everyday lives. In addition, Accenture conducted a survey of 4,650 C-level executives and directors across 23 industries and 35 countries to understand their perspectives and use of emerging technologies across their organizations. The healthcare industry sample comprised 291 provider executives in 10 countries and 100 payer executives in the US. The surveys were fielded from December 2021 through January 2022.

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