Accenture Technology Vision
for MedTech 2022

Meet Me in the Metaverse

How the technology-experience continuum is transforming MedTech

Foreword

MedTech has changed forever.

Many components of the Metaverse have been driving a revolution in MedTech. The opportunity, executed correctly, is to transform payer, provider, healthcare professional (HCP) and consumer experiences for improved patient care. Digital engagement is no longer a "nice to have". It's a "have to have".

MedTech companies are using Metaverse technology like connected devices, digital twinning, data-led insights and virtual collaboration to transform their research and development capabilities.

Accenture survey results indicate that 91 percent MedTech executives believe the Metaverse will have a positive impact on their organizations, significantly higher than the average of 72 percent from other industries. Similarly, 96 percent MedTech executives believed realization of Web3 over the next decade will fundamentally change how businesses engage with users online as compared to 92 percent average response from other industries.

How? The Metaverse creates opportunities for truly humanized digital MedTech ecosystems that meet customer needs across the value chain—in sales, after-sales service, training, and supply chain management. Understanding patient dynamics and post-device outcomes (and learning from them) can improve those outcomes and (for example) set new, more realistic patient expectations about device lifespan.

The MedTech industry is increasingly using edge and blockchain technologies to restore integrity to supply chains. The Metaverse has the potential to enable end-to-end visibility of patients, processes, products, and materials—and help ensure materials are sustainably sourced, too. It creates opportunities for a greater chance of accessible, world-wide, equitable healthcare with blockchain technology helping to solve the underlying root causes of the issues in healthcare, such as protecting identity, security of data and health record management, fraud, consent, management, etc.

The industry faces the opportunity to embrace Metaverse technologies to create robust, meaningful experiences for HCPs, payers, caregivers, and patients.

The metaverse should be viewed as a new interaction platform with as-yet uncharted possibilities that extend opportunities for creativity, innovation and commercial value. From a philosophical perspective, the essence of the human being is the presence of personhood—which can be physical or digital. The Metaverse assumes this principle to unlock human potential (abilities, capabilities, needs) by making physical barriers almost redundant.

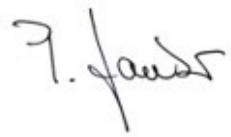
In MedTech, where the physical asset is the delivery of care, encapsulating diagnosis, treatment, and monitoring, the Metaverse takes care delivery beyond anything we previously imagined. Technology, regulation, and patient centricity meet in the Metaverse—lowering the cost of care, extending its reach, and moving to preventive from reactive.

The new worlds created by the Metaverse will unlock existing data and process interoperability challenges across the ecosystem. From HCPs and hospitals to device engineering functions, manufactures and patients will partner to accelerate the path to patient-centric product design, customer-centric supply chain adaptability, and HCP-patient engagement.

For example, Siemens Healthineers[1] is eliminating friction for patients and providers by using technology to improve care accessibility with online scheduling and low-friction websites. The company aims to provide easier navigation along care pathways with contactless and self-service options, location services, and enforcing price transparency. It is also advancing care delivery using patient-centric technology, telehealth and remote patient monitoring. Some MedTech companies are already using software to avoid data bias, and make products based heavily on historical data and success rates. In 2020 Medicrea[2], a Medtronic acquisition, became the first company to offer an integrated spine solution including AI-driven surgical planning, personalized spinal implants and robotic assisted surgery. Medicrea is MedTech's first full-service spine company focused on data-driven surgical planning and personalized implant offerings.

All of this will happen while keeping patient safety, transparency, purpose, and responsibility as MedTech's principles. With the risk of bad actors multiplying and the potential unintended negative consequences to parties and patient populations; the stakes are even higher, needing our industry to step up to the Metaverse opportunity responsibly.

We see the metaverse as a clear and present priority, and MedTech leaders must prepare now. We'd like to present you with a broad, distinctive view that goes beyond just the metaverse, to declutter the picture and move beyond the obvious. Enter the Metaverse Continuum.



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The Metaverse Continuum–touching all of business (and life)

The Metaverse Continuum incorporates all digitally enhanced social and business-related realities. It touches all consumers, workers and enterprises, from reality to virtual and back. Some of its key enabling technologies include cloud, artificial intelligence, extended reality, blockchain, non-fungible tokens (NFTs), digital twins and edge technologies. Like two hemispheres of a brain, the Metaverse Continuum uses a million connections to bring virtual and reality together.

Eventually this spectrum of ideas will coalesce into a more broadly unified experience, but the range of business areas that it will impact will only grow. Just as the internet evolved beyond simple websites to underpin the majority of today's businesses, it would be wrong to think the experience of the metaverse will be constrained to digital space.

That is why we've introduced the "Metaverse Continuum."

Accenture looks at the Metaverse as an evolving and expanding continuum in multiple dimensions because it:

- Comprises multiple technologies including extended reality, blockchain, artificial intelligence, digital twins and smart objects, including cars and factories, and edge computing.
- Encompasses the "virt-real"—the range of experiences from purely virtual to a blend of virtual and physical.
- Describes the spectrum of emerging consumer experiences and the business applications and models across the enterprise that will be reimagined and transformed.

The MetaVerse Continuum has the global ability to bring people and tech together without the limitations of the physical world. While many components of the Metaverse have existed for varying lengths of time within MedTech, bringing them all together creates a seamless world where people, technology, and research coalesce.

ADJUSTING TO THE CONTINUUM

MedTech companies will need to consider how to adjust their businesses to the continuum of rapidly emerging capabilities, use cases, technologies, skills and experiences. Given its importance to the welfare of all humanity, we must seize the Metaverse Continuum opportunity to help ensure that it is developed with responsibility at the core. From ownership of data to inclusion and diversity, sustainability, security and personal safety, this work must begin now.

93%

report that their organization has adapted to the disruption of the pandemic and has found a new normal.

98%

of **MedTech** executives agree that emerging technologies are enabling their organization to have a broader and more ambitious vision.

MEDTECH'S NEW DESIGN: TRANSFORM HOW BUSINESS IS DONE

The MedTech industry is on the threshold of a new decade of digital transformation, and at a defining moment for all leaders. The Metaverse Continuum will transform how businesses operate—everything from how they interact with patients to how work is done. It will profoundly affect what products and services companies offer and how they make and distribute those products.

Patients and MedTech employees can expect vastly more personalized experiences, with the lines between virtual and real-world experiences blurred into a unified Metaverse reality. Leaders need to step back and reimagine the worlds in which they operate, the roles they want to play and the roles that patients will want to define and own—patient centricity will rise to new heights. While we are in the early days of the Metaverse, the pace is picking up fast. If companies don't act now and lead, they'll find themselves following in worlds designed by, and for, someone else.

Rethinking MedTech talent, customer service and research in the Metaverse

There is one variable that spans all trends—particularly for MedTech—and that's talent. Leaders need to think about talent in two ways. First, they need **sufficient quality and quantity of talent to drive company growth in the metaverse** in terms of the four trends contained in Accenture's Technology Vision. That means the right workforce skills, the right culture, the right ways of working and the right employee experience. Accenture itself, for example, is already onboarding new hires through the Metaverse—and they all get virtual reality headsets when they arrive. Leaders need to set up their organizations to work using a boundaryless workforce—remote training and equipment repairs are vital, for example.

People must understand the value of technology and have the skills to use it appropriately. There's a baseline of proficiency that all workers will need to be competent—with value-added skills required for their specialties—like supply chain or customer service. MedTech companies are setting up their customers to serve their own customers in turn. The closer connection between the MedTech company and the end patient means the company can and must act with the patient in mind—and the Metaverse Continuum is the foundation for that expanded relationship.

Second, **companies need to transform how they work for and serve customers**. Customer service representatives can be trained on different medical devices without ever leaving the house or office. Smart supply chains no longer face silos, with end-to-end processes visible and manageable using the Metaverse continuum. **Research and development teams can partner with manufacturing teams** in a meta-lab to work on projects together. With sales and service functions tending to merge over time, call center agents can operate across both. The Metaverse allows for richer customer experiences and more upselling opportunities for agents, who will need to be coached on how to use the new environment. And of course, all this change is driven by data. Leveraging the amount of data being produced will require a new set of skills in itself. Accenture is already using Metaverse technology itself, with virtual office tours available to anyone from any location before they arrive.

People collaborate differently in the MedTech Metaverse – welcome to seamless, boundaryless interaction

Lastly, **organizational culture must adapt to a new reality of seamless, boundaryless interaction**—and do that in a responsible manner. The Metaverse presents a variety of potential challenges, from providing equitable access to technology to keeping patient data secure, to help ensure patients' safety as they explore care in new realms on their own terms and on their own time. This includes liability governance for HCPs, digital health solution providers and MedTech companies.

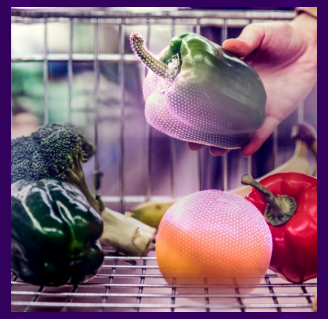
As the Metaverse increasingly dominates business and life, it's critical to have the right governance to help ensure that enthusiasm for its potential doesn't come at the expense of the humans at the center of the experience. Responsible and equitable Metaverse design are key. The actions and choices we make today will set the standards for all that follow. Early innovation in this space can carry outsized value—but it can carry outsized risks as well. Aside from security risks that must be managed, there are equity risks. Leaders are pioneering a new digital future for human and enterprise interaction, but many of the rules remain undefined and enterprises should take proactive steps to build a responsible and equitable Metaverse.

Our Four Technology Trends for 2022

Accenture has identified four key technology trends for 2022, and in this report, we provide a customized view of how they apply to MedTech companies.

WebMe

Putting the Me in Metaverse



Programmable World

Our Planet, Personalized

The Unreal

Making Synthetic, Authentic

Computing the Impossible

New Machines, New Possibilities

Trend 01

WebMe

Putting the Me in Metaverse

WebMe definition

WebMe explores how the internet is being reimagined. The last two years have spurred enterprises to explore new modes of digital experience and pushed people to live virtually to an extent they never expected. Now the metaverse is emerging as a natural evolution that reconciles how the internet is designed today, with what we will demand from it going forward. The advent of the metaverse, and underlying efforts to reimagine how data shapes our digital experiences, will challenge businesses to rethink their presence online and become a part of shaping the next platform revolution as they build new ways to connect to customers, partners and their digital workforce.

WEBME: WHAT IT MEANS FOR MEDTECH

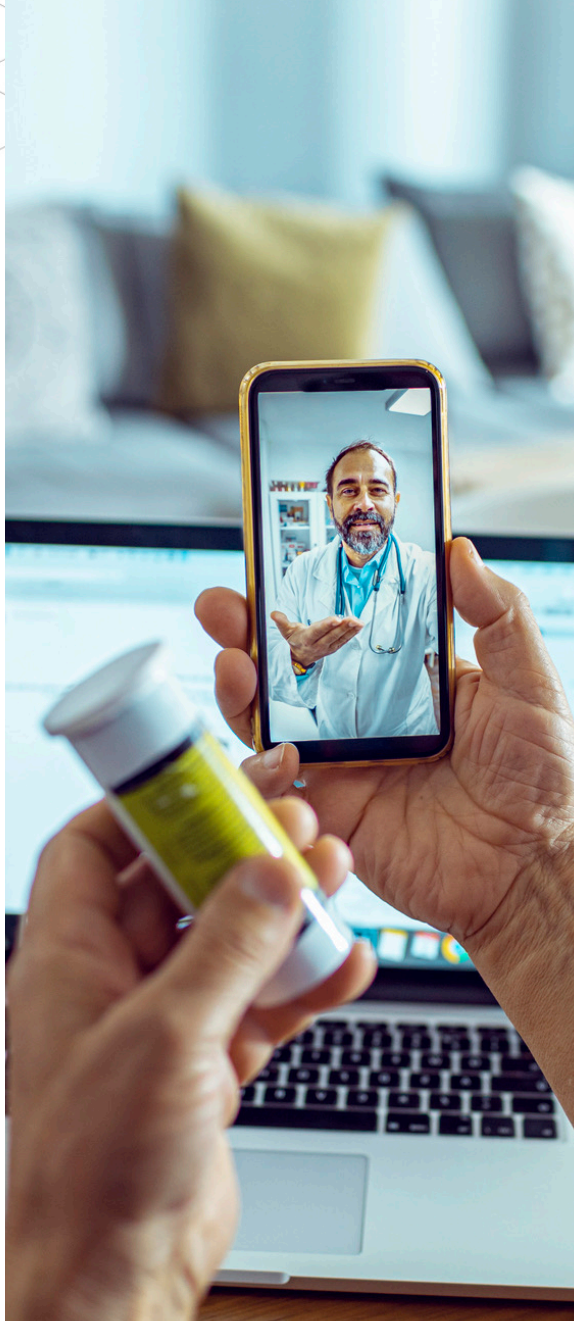
The best healthcare services exhibit proactive and consistent interaction between patients and doctors. The Metaverse will play a vital role in managing this process effectively. It has the power to transform the current healthcare delivery model by opening new treatment delivery channels, lowering costs, significantly empowering the patient and improving patient care outcomes.[3]

WebMe empowers patients through transparency and translation, which improves patient knowledge of and participation in the therapeutic journey. WebMe makes Diagnostics, Treatment and Monitoring understandable and accessible to patients via MedTech devices, solutions and platforms. It acts as the interface between the physical and the virtual. For example, NFTs can be used to tag blood test results to particular patients and, along with blockchain, ensure that results are transferred from the physical world to the virtual without losing the integrity of being linked to a specific patient.

Greater patient involvement and compliance extends the effectiveness of devices and therefore has a direct impact on patient outcomes. It may even lead to lower costs. MedTech is also entering the world of precision medicine—creating devices which are crafted for the individual, improving accuracy and patient outcomes.

Blockchain has the potential to make administrative, care delivery, and payment processes transparent. It reduces fraud and administrative burdens on the doctor, insurer and patient. It also allows the user or patient full autonomy over their data[4].

Sensitive patient health data is scattered across platforms and is difficult for operators and patients to access. In fact, over 1.2 billion clinical documents are produced in the US every year—yet 80% of that data is unstructured or locked away. With NFTs, all this sensitive and critical information would all exist in one place: a patient medical "passport" that's secure and accurate[5].



REAL WORLD WEBME EXAMPLES

The **Metaverse Doctors Alliance (MDA)**[6] was formed in December 2021. It is a new effort to deliver virtual healthcare globally, using blockchain to increase care access while protecting privacy. The Metaverse creates opportunities for more accessible, equitable healthcare world-wide. It will use blockchain technology to address underlying data issues like identity protection, data security and health record management, fraud, consent and data management.

WebMe as part of the Metaverse will address one of the key pain points of medical care – patient adherence. A lack of patient adherence increases the cost of care. It also lowers safety and efficacy and results in relapse or comorbidities. Through the translation and personalization of complex medical terms, treatments and therapies, WebMe will fine-tune the levers for patient adherence: knowledge, access, and support. Metaverse will create a completely new experience tailored to the patient. From diabetes monitoring devices and heart valves to gastric lap bands, the emotional and intellectual imprint of WebMe on the patient will ensure treatment adherence and provide early warning systems to address its absence.

As wearables and other tracking devices gain popularity and mass-adoption, entrepreneurs are leveraging NFTs to decentralize data collection, optimize access, and give patients back control of their health records. For instance, **Aimedis**, an in-house NFT marketplace, allows patients to process their data as NFTs and easily forward it to their doctor, dentist, or physiotherapist.

91%

of MedTech executives state that the **Metaverse will have a positive impact on their organizations**, with 36% as a breakthrough or transformational impact.

Trend 02

Programmable World

Our Planet, Personalized

Programmable World definition

The Programmable World tracks how technology is being threaded through our physical environments in increasingly sophisticated ways. It projects how the convergence of 5G, ambient computing, augmented reality, smart materials, and more are paving the way for businesses to reshape how they interact with the physical world. As technology becomes part of the fabric of our environment, it allows us to treat our environment more like technology—unlocking an unprecedented fidelity of control, automation, and personalization.

PROGRAMABLE WORLD: WHAT IT MEANS FOR MEDTECH

The last two years have completely changed the trajectory of digital transformation in all industries, but especially MedTech, biopharma and health. Customer engagement and experience remain the crucial parameters. Virtualization and technology-driven disruptors like extended reality (XR) and 5G are playing pivotal roles in delivering almost real-life personalized experiences to customers.[7] 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. Our survey confirms the trend—89 percent of MedTech executives believe that programming the physical environment will emerge as a competitive differentiation in their industry, higher than the 79 percent average response from other industries.

The first layer of programmable world technology is the focus on creating a connected foundation. Four out of five biopharma executives we surveyed say the number of Internet of Things edge devices deployed in their organizations has "significantly" or "exponentially" increased in the past three years. Connected technology has changed healthcare, and the industry isn't stopping at the device alone. It's deployed solutions that include diagnostics and monitoring and enable continuous care through end-to-end connectivity. Digital trials have moved into the home—and patients can operate their own devices. Doctors use mobile devices to monitor patients' hearts after hospitalization—for a stroke or a new heart valve, for instance.

The next layer of the programmable world is experiential. It can sense and change its own characteristics: digital twins and augmented reality (AR) are core constituents of this layer. Augmented reality (AR) in MedTech is seen as a potential game changer with its application across customer service, compliance assurance and customer experiences. In fact, 99 percent of MedTech executives report their organization would consider using AR in the next three years. AR creates opportunities for experts to meet where real-world limitations would have prevented meetings in the past. But beware: without reinventing underlying processes, the organizational problems of the physical world will be the same in the Metaverse Continuum.

Extended reality (XR) solutions have become popular in MedTech and are revolutionizing various medical processes—from prevention to diagnosis support and surgical interventions to patient rehabilitation. XR could improve patient experience. For instance, physicians could virtually walk the patient through what a procedure would entail using XR visuals, as opposed to simply explaining it[8].

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. There are now many connected programmable devices—from implantables that transmit heart rates in real time to live electronic medical records that connect patients to their constantly updating medical histories.

Now, as the real-world impact of the current digital revolution begins to hit critical mass, we are embarking on a programmable world-driven transformation. 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 more easily and accurately than ever before. There are significant challenges in connecting these technologies safely and at scale— data interoperability and cyber security. MedTech enterprises will build and deliver these experiences, building the rules to overcome these challenges and reinventing their own operations for a new world where physical spaces are adaptable to cues, or our needs, while improving environmental sustainability.

89%

of MedTech executives believe programming will emerge as a competitive differentiation in their industry and **75%** agree that augmented reality will disrupt their industry in the next three years.

REAL PROGRAMMABLE WORLD EXAMPLES

Digital twins enable developers to test medical devices' characteristics or uses. They can then make design or material changes and test the modification's success or failure virtually—before spending money on manufacturing. This significantly reduces the cost of failures and enhances product performance and safety. Twins also allow customers to "see" what they will be receiving and contrast the benefits of different products.

Roche's **NAVIFY® Oncology Hub**[9] is a digital solution to further enhance clinical decision support and workflow optimization for oncologists and oncology care teams. NAVIFY® Oncology Hub addresses these challenges by securely aggregating and organizing fragmented patient data across an institution's IT systems. It simplifies day-to-day workflows for oncology care teams and serves as a central workspace where the most relevant patient data can easily be found, accessed and reviewed by all members of the team. NAVIFY® Oncology Hub presents the information as a longitudinal timeline view of the patient's full oncologic history, combined with a concise snapshot of the individual's current status. With it, clinicians can efficiently prepare for patient consultations, quickly and concisely convey information and coordinate care across the team. NAVIFY® Oncology Hub also helps facilitate discussions between oncologists and patients about complex treatment options and next steps.

Fresenius Medical Care is also developing innovative technologies designed to accelerate the growth of home therapies by making **home dialysis systems** smarter, more intuitive and easier to use for people living with kidney failure. VersiPD[10] is designed to improve health equity by making home therapy a more feasible option for a broader population of dialysis patients. VersiPD is supported by the Kinexus™ Therapy Management Platform, a connected health system that aims to improve patient outcomes and nurses' productivity through remote therapy monitoring and programming capabilities.

Fresenius has launched a **VR-based training program for people undergoing home dialysis** in Germany, its home market ahead of a rollout in other countries later this year. The VR system – called stay safe MyTraining VR[11] – is designed for use in patients undergoing peritoneal dialysis, which uses the peritoneum in a person's abdomen as the membrane through which fluid and dissolved substances are exchanged with the blood. Training in peritoneal dialysis can take four to six weeks, sometimes with familiarization beginning in the dialysis unit and then being continued at home.

Stryker[12] spine business unit "provides 3D-printed technologies, enabling surgeons to provide their patients with treatment options" that allow for "bone in-growth and biological fixation", resulting from improved porosity and "a favorable environment for cell attachment and proliferation". Coupled with digital solutions like SpineMap 3D software with its intuitive, customizable design it helps surgeons create personalized workflows and enhance efficiency in every procedure. All focused on the surgeon's experience from pre/intra/post-op, enhancing their surgical decision making and performance.

Trend 03

The Unreal

Making Synthetic, Authentic

The Unreal definition

The Unreal is a trend where our environments and businesses are increasingly filled with machines that are passably human. "Unreal" qualities are becoming intrinsic to AI, and the data, that enterprises aspire to integrate into mission-critical functions. At the same time, people are coming face-to-face with bad actors using this technology—from deepfakes to bots and more—igniting a growing concern that may turn into the biggest hurdle for enterprises looking to grow their use of AI. Like it or not, enterprises have been thrust into the forefront of a world questioning what's real, what isn't, and if the line between those two really matters.

THE UNREAL: WHAT IT MEANS FOR MEDTECH

Clinical AI algorithms are revolutionizing the medical device industry. For example, enhanced algorithms are looking at EKGs in previously unimagined ways. Machine learning is helping us to look through 3D CT scans and other images to identify cancers and other abnormalities. From image-based diagnosis in radiology and dermatology to surgery, to patient monitoring and assistance—more than nine out of ten (91 percent) MedTech executives report that their organization is dependent on AI technologies to function effectively. This is significantly higher than the 80 percent average response from other industries. But to make good decisions, AI needs to learn by interpreting results.

Synthetic data is being used to train AI models in ways that real-world data cannot or should not. This realistic (yet unreal) data can be shared without the usual privacy concerns, while maintaining the statistical properties of real data. It can even include diversity to counter bias—not always possible with real-world data. In MedTech, synthetic data has particular value for things like training AI-based models or creating simulations for robotic surgery. Deployed authentically, synthetic "reality" can drive AI effectiveness further and faster. In our sample group, 97 percent of MedTech executives report that their organizations are committed to authenticating the origin of their data, and to genuine use of AI. However, despite the hype and potential, there is lack of trust in the technology. In fact, 98 percent of MedTech executives report concern over deepfakes and disinformation attacks.

A significant obstacle that needs to be overcome when it comes to AI is legal liability. When it comes to decision support for doctors, customers don't want to pay, but, more importantly, regulators don't know how to handle the legal ramifications. Who takes responsibility if the machine makes an imperfect diagnosis? For now, the answer seems to be that doctors continue to sign off on AI diagnoses, but MedTech companies are trying to figure out how to make AI responsible. The problem has a quality assurance component, a liability component and a reimbursement component. In the US, the FDA is trying to grapple with the fact that while products are designed and tested, AI is a learning/adaptive tool—so how do you ensure that as it adapts the robot is still safe?

PROVENANCE

One way to verify the provenance of digital content and identity – thereby demonstrating authenticity – is through the 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, your values.

PEOPLE

Having these governance structures in place is imperative to handle the inherent risks baked into the unreal world of 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 nonsynthetic 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.

Using generative AI in an authentic way means taking heed of provenance, policy, people and purpose.

97%

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

REAL WORLD EXAMPLES OF THE UNREAL

The **Internet of Medical Things** (IoMT) enables remote patient monitoring[13] in chronic or long-term care cases. Caregivers can receive biometric information from wearable devices[14], track patient medication orders—or trace their locations after admission. Infusion pumps that connect to analytics dashboards and hospital beds rigged with sensors that measure patients' vital signs are medical devices that can be converted to or deployed as IoMT technology.

Robots performing minimally supervised surgery are becoming a reality. Relatively antiinvasive procedures like endoscopies and colonoscopies can already be done by robots, and trained robots can work on production lines.

Applied intelligence (AI) has several applications in Software as a Medical Device—like AI trained to detect an arrhythmia in an electrocardiogram. AI can predict the results of any scan or procedure, thereby providing radiologists and doctors with better diagnostics.

Some MedTech companies are already using software to avoid data bias, and make products based heavily on historical data and success rates. In 2020, **Medicrea**[15], a Medtronic acquisition, became the first company to offer an integrated spine solution including AI-driven surgical planning, personalized spinal implants and robotic assisted surgery. Medicrea is MedTech's first full-service spine company focused on data-driven surgical planning and personalized implant offerings.

A synthetic COVID-19 patient data platform (created by startup, MDClone[16]) was used by Israel's largest hospital in the early days of the pandemic. The resulting data was shared with academic researchers and other organizations which could innovate quickly and create an algorithm that helps clinicians determine when patients should be given drug treatment or sent to the ICU.[17]

Another example of **synthetic data in MedTech** is a mobile app called M-sense. This app is designed to help migraine patients track their condition, gain a deeper understanding of it and reduce migraine symptoms. The app collects data from patients, and that data is used to create synthetic clinical data that migraine researchers can then use for their studies.[18]

AI has an important role in improving patient interactions. A distinctive feature of the AI-based chatbot technology is that it has been humanized to make the health assistants intuitive, patient-centric, and patient-friendly. Medcare, a UAE-based hospital group, recently announced the launch of its new "virtual health assistant" chatbots. The two new health assistants use advanced artificial intelligence (AI) algorithms to learn about the patient, personalize responses and give accurate information in real-time. The health assistants are the only chatbots in the region that allow the patient to manage all aspects of their appointments online, including booking, rescheduling, and canceling, permitted by real-time back-end database integration.[19]

Prenosis It is developing an "assisted intelligence" system to better diagnose sepsis (historically very tricky), using a machine learning algorithm and holistic input data from 23 parameters including three biomarkers (Interleukin-6, procalcitonin, and Creactive protein) to help profile the patient's underlying biological state accurately.

Trend 04

Computing the Impossible

New Machines, New Possibilities

Computing the Impossible definition

We are on the precipice of resetting the boundaries of traditional industries as we begin computing the impossible. The outer limit of what is computationally possible is being disrupted as a new class of machines emerges. Quantum, biologically inspired, and high-performance computers are each allowing companies to tackle grand challenges that once defined and shaped the very core of their industries. As problems once considered impossible become ever more solvable, business leaders will be pushed to reimagine how to harness the next generation of computing power.

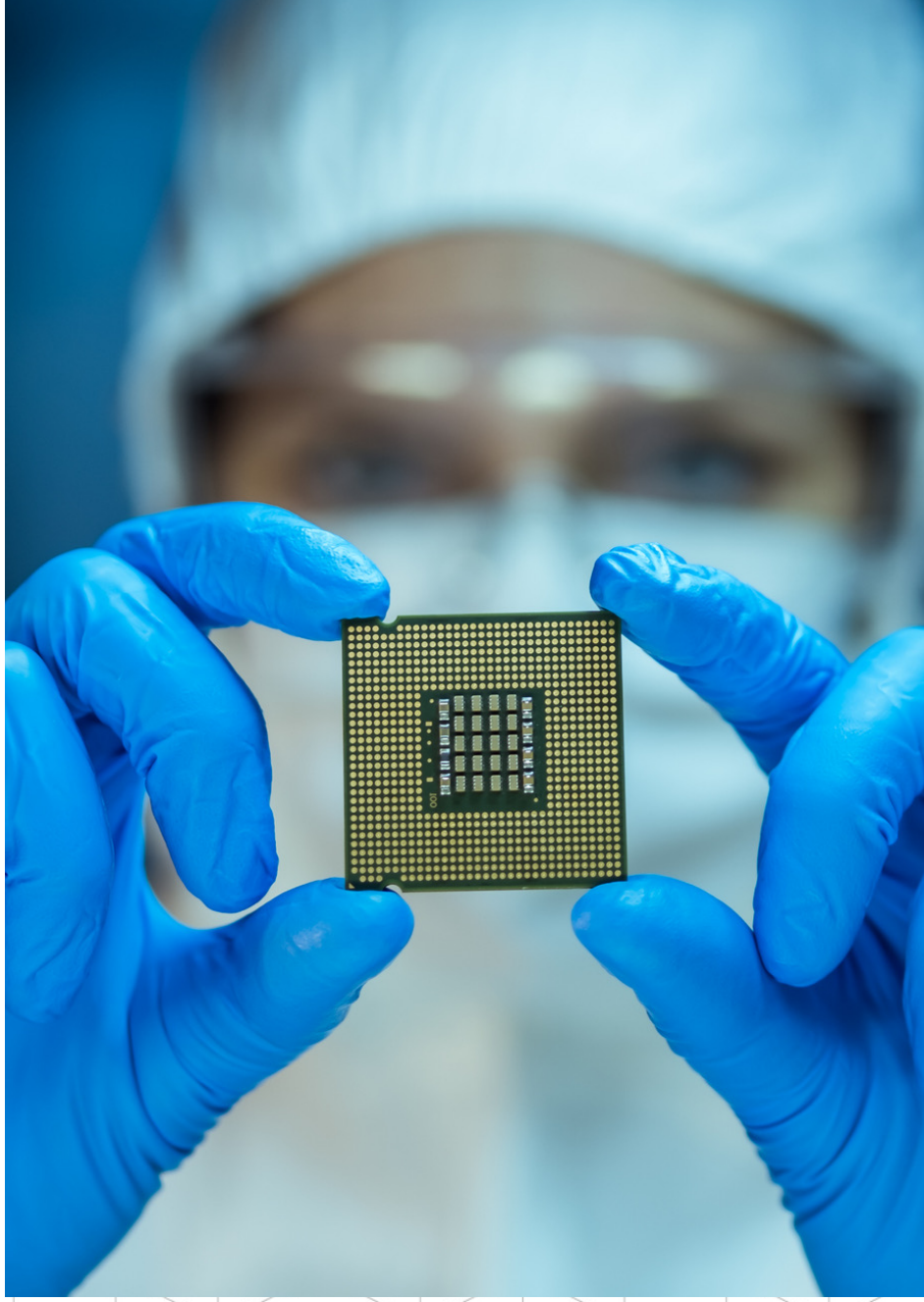
COMPUTING THE IMPOSSIBLE: WHAT IT MEANS FOR MEDTECH

Computing muscle could significantly enhance data-rich research and development processes. More computing power means faster, better-quality research and development at a lower cost. Regarding data science as a product, or feature of a product, gives MedTech companies a different paradigm for execution focused on a tangible outcome.

Computing the impossible will allow for easy analysis of productivity drivers and trends. Data and analytics can be used to reduce defects in the medical software development process, especially with embedded software or SAMD. Faster analysis of patient usage patterns can help to improve patient experiences, while clinical trial efficiency and site selection can be improved through artificial intelligence (AI). That means a faster introduction of new devices and patient treatments. Just as e-trade experienced in the early 80s, Computing the Impossible will provide a platform for lightning-fast device and medical solution research and development.

In our study, 96 percent of MedTech executives agreed that their organization is pivoting in response to the unprecedented availability of computational power, higher than the 91 percent average response from other industries. Computational power can be of various types—quantum computing, high performance computing and bio-inspired computing. As per our survey results, 78 percent of MedTech executives say quantum computing will have a breakthrough or transformational positive impact on their organizations in the future, while 64 percent say the same for high performance computing (HPC) and 30 percent for bio-inspired computing.[20]

Biology-inspired computing takes advantage of the most mature system 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.



REAL WORLD COMPUTING THE IMPOSSIBLE EXAMPLES

Computer-aided detection and diagnosis methods for medical images have been rapidly developing. At the same time, many of these images are impacted by noise, poor resolution, and low replicability. Quantum sensors can improve the MRI machine itself by allowing ultra-precious measurements. A novel type of quantum-based MRI could be used to look at single molecules or groups of molecules instead of the entire body, giving doctors a far more accurate picture. Hypres is an example of a company that is working to retrofit MRI machines to be more sensitive–and to work faster.[21]

Recent **advances in quantum technology** have enabled the design and commercial production of lightweight and flexible optically pumped magnetometers (OPM) sensors, such as those being incorporated into magnetoencephalography[22] scanners[23]. An electroretinogram (ERG) is a standard clinical method for measuring the function of the human retina. This procedure typically uses either a contact lens electrode or a fiber electrode to record retinal activity, both of which require physical contact with the eye, and therefore cause discomfort for the patient. Researchers at Aarhus University in Denmark have tested a potential replacement for these uncomfortable electrodes by using OPMs.

Quantum computing can be used to analyze vast amounts of data being collected through wearables, electronic health records and sensor-based instruments. Collating data from different sources reveals correlations and inferences to give a holistic view of the medical condition. Innovations built on the principles of quantum mechanics hold the potential to affect health care on nearly every level, from diagnosis and treatment to data storage and transmission.

Neuromorphic chips, like **Intel's Loihi**[25], have introduced a brand-new design to computer chips: they are modelled after the human brain. The chips use artificial neurons to transmit information in a way that is more power-efficient than traditional CPUs. **George Washington University** is helping to open the door to bio-compute through **the BioCompute Object Specification Project**[26], which is an informal community that aims to streamline data and workflow exchange between the FDA, researchers, pharmaceutical companies and bioinformatics technology developers.

Spark Biomedical It created and sells an FDA-cleared, drug-free, wearable technology – the Sparrow Therapy System – worn around the ear for opioid withdrawal relief. The system has three parts: (1) an earpiece that delivers mild electrical stimulation to the nerves around the ear to release endorphins and reduce symptoms; (2) a Patient Controller that adjusts the intensity of the electrical stimulation; and (3) a Clinician Programming App with Bluetooth that improves how clinicians can treat patients.

Companies like **Neuralink**[27] are working to build tools to communicate with the brain—ultra-high bandwidth brain-machine interfaces to connect humans and computers.

78%

of MedTech executives say quantum computing will have a breakthrough or transformational positive impact on their organizations in the future, while **64%** say the same for high performance computing (HPC) and **30%** for bio-inspired computing.

The reality of the Metaverse Continuum in MedTech

The continuum from reality to virtual may seem futuristic, but it's standing at the front door. The following two personas bring light to the way roles within a MedTech organization can improve and expand within the metaverse.

Meet Jeff | The commercial operations lead

Jeff leads a North American MedTech giant's commercial operations team. He uses underlying data from the entire supply chain to maximize commercial benefit. He does so by optimizing stock availability to meet customer demand so that patients get medical devices when and where they need them. Jeff's overall goal is still to get the product to market as efficiently as possible. He must be aware of sales representatives' footprints to help ensure his customers are covered and take responsibility for financial forecasting based on pricing and profit margins and understanding the company's performance against contractual obligations.

THE FUTURE

In the past, Jeff's sales representatives would have had to troubleshoot orders and requests by going back to the office or, at best, phoning colleagues to enquire about the availability of stock or to make a non-standard request. The truly Metaverse-empowered sales representative has all those resources readily available and can collaborate and consult seamlessly across his peer function teams (product engineering, marketing, supply chain and his sales reps) to deliver on demand and personalized experiences to his key customer base. This will be a meta-channel with Jeff and his account sales teams acting as quarterbacks, directing and enhancing customer and patient experiences in the evolving hybrid B2B/B2B2C/B2C MedTech world.

For Jeff, the key questions to consider in the MetaVerse context are:

- What structural and process changes are needed in omnichannel sales, marketing, and fulfillment organizations?
- What changes for my colleagues in product design, manufacturing, sales, and supply chain in the Metaverse?
- What changes for my customers and for their patients?

Today's silos need to be smashed irrevocably if MedTech companies are to future-proof their organizations and lead the market. Customers need products when they need them – they don't care about internal limitations. Their expectations, and those of MedTech's customers (providers) are set by experiences outside MedTech itself. Amazonification is a common thread that entails a single, optimized customer experience irrespective of production, inventory and supply chain limitations. Patients are used to tracking their parcels using underlying straight-through processing that keeps them informed and empowered.

The Metaverse enables agile, virtual meetings to engage in proactive customer experience planning and improvement—right at the coalface and potentially even including customers and patients themselves. Creative use of Metaverse technology allows for unprecedented visibility of the supply chain and retention of customer and patient loyalty through rewards.

On the manufacturing and supply chain side, Jeff can take a more proactive product planning approach. MedTech's traditional manufacturing approach is to plan an account by setting targets and base production runs on those targets. Now, embedded AI could create a more intelligent, flexible supply chain that understands and adjusts to the changing needs of various healthcare customers. Greater transparency of fluid demand and inventory levels reduces the number of avoidable stockouts. Open APIs with value-chain wide access to data coupled to that same AI, enable intelligent management information and customer segmentation. Understanding who his top 50 customers are and why enables Jeff to understand the impact of commercial operations on their satisfaction levels more directly. Ultimately, it means he has the right product available for the right patient at the right time.

Meet Linda | The product design lead

Linda manages product design for a UK-based global MedTech firm. She has a strong background in engineering, with a good understanding of the Life Sciences and MedTech provider ecosystem and customer landscape. During her time in the industry, her knowledge of human anatomy has also grown considerably.

THE FUTURE

Linda's Metaverse future looks vastly different to her past. Her role is to understand where products are already available, what new market gaps need to be filled and how to fill them using the latest technology. The design process involves many iterations to iron out design flaws and update prototypes. Version controls are vital because the perfect design may require functionality or design features from a previous prototype.

Unlike in the past, where prototypes required physical engagement with selected doctors and patients signed up to help complete trials, today Linda's design trial population participating in the meta-clinical trial is diverse. Greater penetration means greater diversity, means less chance of adverse effects due to limited availability of test subjects. The Metaverse dramatically reduces trial time, time to market and massively improves the trial feedback loop.

Linda's design team uses the Metaverse's digital twins and computer-aided design that allow for rapid creation and preliminary testing of virtual prototypes. The team shares these in the meta-lab for fast scenario testing to help ensure efficacy and interoperability with other necessary devices or equipment from different OEMs.

Linda also uses AI driven by synthetic data to embed safety and efficacy into the product's design. Linda, with peers in other companies, will work with regulatory bodies to share these AI algorithms but also collectively help build the MedTech world's new rules. The aim is to reduce regulatory approval cycles while ensuring that failures and adverse effects are avoided. Linda's team is improving device design with feedback from key accounts.

In surgery, the metaverse allows for a digital twin of a patient to be created before surgery to determine, for example, the optimal depth for a linear hernia incision. The Metaverse even allows for a more experienced surgeon to guide a junior colleague remotely, using the digital twin, to ensure patient safety and maximum health benefits. This is the Metaverse in MedTech, delivering better access, better customer experience and improved outcomes for patients.

Where should you begin?

MedTech companies stand at a unique precipice in time.

While much of this technology is still in the early adopter phase, there are signals that the future world will bring us closer to meeting the unmet needs of patients, employees and healthcare professionals in previously unimagined ways. It will be about putting humanity at the core by designing better experiences for improved outcomes for our patients, improving the HCP experience and having better and more resilient supply chains. MedTech companies need to build a truly competitive vision – both for what these future worlds will look like and what their enterprise will need to become to succeed in them. But what are the next steps?

In terms of **WebMe**, there are already some standard metaverse use cases that companies can leverage without high levels of risk. For instance, immersive technologies for training or productivity have been tested and experimented with for years. To guide their pilots, businesses should investigate how their enterprise platforms may be holding them, their stakeholders, or their users back. They should empower development teams to design and set new kinds of experiences that cut or circumvent these pain points. Finally, they must pay attention to signals coming from partners and other comparable industry companies. Seek out opportunities for joint investments, like consortiums, with others facing similar challenges and increase collective access to emerging computing.

In the **Programmable World** enterprises need to prepare to adapt over time as new programmable world technologies mature. Investing in digital twin and IoT technologies will position enterprises with the experiential and data foundations they need to rapidly innovate and respond to new developments over time. As this space is still budding, it is critical leaders revise the way they consider return on investment, and what key performance indicators look like. Creating successful pockets of innovation throughout the enterprise will mean creating the space for safe experimentation and the ability to fail fast and iterate, while exploring new avenues for the future.

The Unreal will require exploration of synthetic data. Determine how its advantages could improve existing data strategies, and the algorithms and AI fueled by them, like improving data set quality, reducing privacy risk, and correcting for bias present in historic data sets. Identify where unreal content like chatbots or AI-generated images, video, or content could help extend your brand and/or create preferred interactions with customers. Find ways it can create new avenues of connection with your sales teams, HCPs, planers other employees to improve the quality of their experiences, and drive new outcomes. Authenticity must become an enterprise-wide priority and a C-suite responsibility for generative AI. Know that regulations are formative in this new territory of the unreal world. Have each of your major enterprise functions identify the existing regulations they must adhere to and close the gaps with internal policies that align to company values. These should be reported up to the accountable C-suite leaders who should maintain a regular agenda item concerning the impact of AI to their business, and how to hold it to a higher standard.

When it comes to **Computing the Impossible**, start making bets on the future of computing. Establish a group to scan and benchmark any developments. Meeting quarterly or semi-annually to match the pace of change in your industry will help you predict which class of machines is likely to impact your enterprise the earliest, and in what way. The new problems that companies can – and will – start to solve are too big for anyone to tackle alone. Partnerships are no longer optional, and enterprises should already be starting to build relationships with next-generation computing providers, which are increasing in number and variety.

There is a significant technology talent shortage already, and it only gets more severe as technologies and their associated skills become more advanced. Create a people strategy that prioritizes skills identification, acquisition, and development. Enterprises that do not start competing for talent soon are setting themselves up to fall behind.

Who better than the MedTech industry to appreciate that they must manage the risks carefully? Leaders are not just pioneering new digital future, but a new future for human and enterprise interaction, and many of the rules remain undefined. It is critical that MedTech companies take steps to shape the Metaverse Continuum proactively and responsibly.

Technology points us in the right direction, the rest is up to you.

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Sources

1. Siemens Healthineers, Frictionless healthcare: Why it matters and how to get there, Link, December 1 2021
2. Medicrea, Link
3. Metaverse: The next frontier for Healthcare 4.0, Netscribes, Link, 01 April 2022
4. Blockchain, the Metaverse, and Medtech, MDD Online, Link, 19 May 2022
5. Tal's NFT take: Healthcare is the Newest Frontier for NFTs, The Street, Link, 30 Nov 2021
6. MD+DI, January 19, 2022, https://www.mddionline.com/digital-health/blockchain-metaverse-and-medtech (accessed 06/06/2022)
7. Time to reshape the digital healthcare domain, ToI, Link, 02 April 2022
8. How XR is boosting medical device product development, Medical Design Outsourcing, Link, 2 Oct 2019
9. Roche, June 2021, Roche launches NAVIFY® Oncology Hub to simplify clinical workflows and empower timely, personalised decisions across the oncology care continuum, https://diagnostics.roche.com/global/en/news-listing/2021/roche-launches-navify-oncology-hub.html (accessed 07.13.2022)
10. Freenius Medical Care, April 2022, Fresenius Medical Care receives FDA clearance for Versi™PD Cycler System, https://www.freseniusmedicalcare.com/en/news/fresenius-medical-care-receives-fda-clearance-for-versitmpd-cycler-system (accessed 07.13.2022)
11. Immersive Learning News, August 2021, Fresenius launches VR-based training for home dialysis patients, https://www.immersivelearning.news/2021/08/09/fresenius-launches-vr-based-training-for-home-dialysis-patients/ (accessed 07.13.2022)
12. Stryker, We are a global leader of complex spine and minimally invasive solutions focused on achieving three-dimensional Total Body Balance, https://www.stryker.com/us/en/spine.html (accessed 07.13.2022)-
13. https://www.techtarget.com/searchhealthit/definition/remote-patient-monitoring-RPM
14. https://www.techtarget.com/searchhealthit/definition/mHealth
15. https://www.medicrea.com/en/
16. https://www.mdclone.com/
17. Tech Vision Example, Accenture research
18. How Synthetic Data is Used in Healthcare, TripleBlind, Link
19. Chatbots for healthcare: AI assistants to the rescue, Omnia Health, Link, 20 May 2022
20. Exploring quantum computing use cases for healthcare, IBM, Link
21. 4 Ways Quantum Technology Could Transform Healthcare, E-Spin, Link, 24 Han 2018
22. Magnetoencephalography is a relatively new technology in which we measure the magnetic fields generated by current flowing through neuronal assemblies
23. Quantum sensors could revolutionize retinal diagnostic procedures, Physics World, Link, 14 Oct 2021
24. Exploring Potential of Quantum Computing in Creating Smart Healthcare, Research Gate, Link, Dec 2021
25. Intel, Loihi 2: A New Generation of Neuromorphic Computing, Link, Oct 2021
26. George Washington University: BioCompute Object Specification Project, Link, May 14 2020
27. https://neuralink.com/

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.

The MedTech industry sample comprised 100 executives in 10 countries (Australia, China, France, Germany, Italy, Japan, Netherlands, Switzerland, United Kingdom and the United States). Surveys were fielded in April 2022.

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