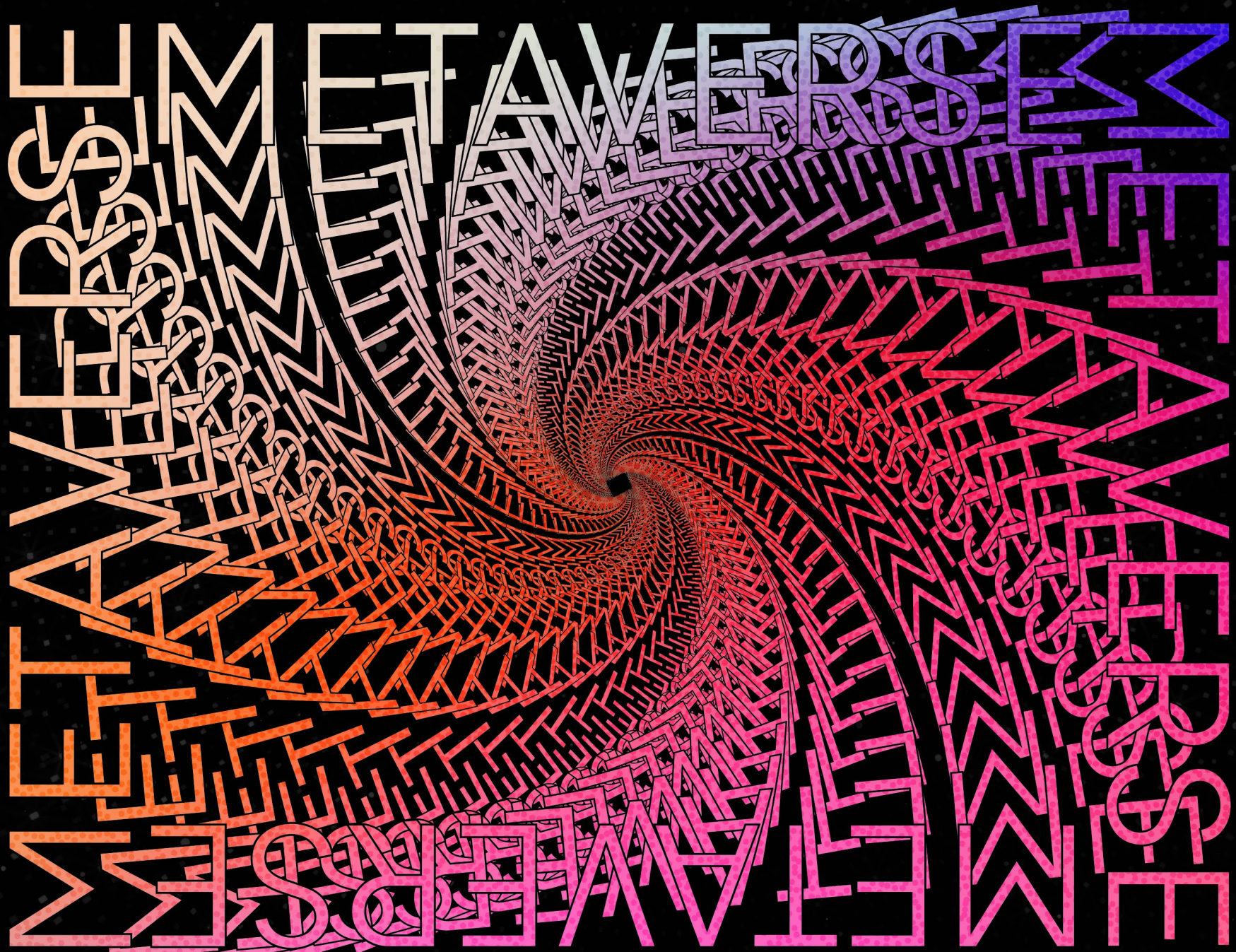
16TH EDITION • 2023 TECH TRENDS REPORT • METAVERSE



Future Today Institute

Detailed analysis of the metaverse, with key trends in synthetic media, XR, AR, VR and DR.

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THIS YEAR REQUIRES FOCUS

In August 2017, a rare explosive event known as GW17817 took place in space. Two stars collided, unleashing a blast energetic enough to form an incalculable number of new stellar bits that continue to travel through interstellar space. Over time, this stardust will combine into small objects, evolve into large rocks, fuse with even more material, and form into planets. One incredibly violent disruption will someday lead to the formation of a new corner of the universe. This is how our own sun and Earth, and all of human existence, came into being.

Lately it's as if we've been living through the aftermath of cataclysmic explosions: the release of generative artificial intelligence systems like ChatGPT and Midjourney, a fusion breakthrough that could someday generate zero-carbon energy, Russia's ongoing invasion into Ukraine, deep uncertainty about a global recession, and AlphaFold's protein-folding algorithms that predicted structures for nearly all cataloged proteins known to science, to name a few. These and other forces of change are colliding, going supernovae, and resulting in an unfathomable amount of new signals—bits of change that, over time, result in the trends that shape society.

Now more than ever, it's important to carefully track new trends as they emerge. But that isn't easy, given the rapid pace of change. For that reason, the theme of our 2023 Tech Trends report is Focus. It is crucial to focus when new signals are forming because some may be lasting and develop into impactful trends, while others might burn out and fade away. In an increasingly complex and fast-paced world, leaders who focus on the trends that matter and adapt to changing circumstances make better decisions and see improved outcomes. Trends enable them to anticipate near-term change, understand the factors influencing their industries, and develop a point of view on the future.

Our research is presented in 14 in-depth reports that reveal the current state of play, a list of influencers to watch, key trends, detailed examples, expert perspectives and recommendations designed to help executives and their teams develop their strategic positioning. Some of the trends are new advancements on mature technologies, while others represent frontier technologies and areas of science. When we look at them collectively, new centers of gravity come into focus, and we can glimpse the impacts they will have on every sector.

Trends on their own cannot predict the future. Rather, future-focused organizations use them to deeply reflect on the tension between long-term and short-term goals and to reduce uncertainty. By understanding the trends and changes shaping the landscape, executives can make informed decisions and capitalize on new opportunities in the year ahead.

We invite you to join us in observing how the stardust settles into new signals and trends. Share your feedback with us at **2023trends@futuretodayinstitute.com**.

Amy Webb
Chief Executive Officer
Future Today Institute

STATE OF PLAY

The metaverse - a collective virtual shared space - may not be fully developed yet, but its impact on industry and consumer interactions is already widely felt.

Last year, industry leaders successfully redirected Big Tech's media attention away from societal ills and toward using Web3 technologies to build the next big thing in the metaverse. Google searches for "metaverse" shot up 7,200% year over year. But the second half of 2022 offered a stark reality check: After the hype fueled by pandemic-driven future-of-work imaginations, a mega Meta rebrand, and venture froth, tech firms big and small finished the year amid economic headwinds, dropping valuations, layoffs, and austerity. Snap cut staff by 20%, though remains committed to developing its augmented reality glasses. Unity's and Niantic's layoffs affected 4% and 8% of their respective workforces. IDC lowered its outlook for AR and virtual headset shipments in 2022 by 12.8%. Tinder is scaling back its metaverse plans and in-app Tinder Coins in the face of falling profits.

STATE OF NEW REALITIES IN 2023

Before the near-term skepticism and belt tightening set in, the convergent trends in artificial intelligence, generative AI and synthetic media, Web3, and digital assets seemed to set up new realities as an inevitability of technological progress. Estimates for the metaverse's total economic impact by 2030 range from $5 trillion to $13 trillion. Execs and analysts alike started to take Roblox, Fortnite, and Minecraft seriously; after all, the kids might have insights given the proto-metaverse in which they're already playing. Brands across the spectrum started to dip their toes into the metaverse slipstream, with Snapple creating a bodega in Decentraland and Ralph Lauren placing its iconic polo player on a llama for a Fortnite collaboration. Chief metaverse officers were appointed across agencies, media companies, luxury brands, and consumer goods companies. Exclusive collections simultaneously dropped for both digital avatars and real-world Fifth Avenue fashionistas. Burning Man and Coachella dabbled in virtual reality and AR experiences. Early industrial and health care applications using digital twins have shown new realities to be far more than just child's play or entertainment. We've even seen the first metaverse protests take place in virtual worlds like Cryptovoxels and Decentraland.

Mark Zuckerberg's lo-fi tourist selfie and leg mockups may have made a meme-worthy mockery of the metaverse, but tech's biggest players continue to lay the infrastructural groundwork toward their vision for the next computing interface. Meta's Quest Pro introduced face and eye tracking and passthrough for extended reality (XR) capabilities, albeit at an enterprise procurement sticker price and to underwhelming reviews. Despite Meta's struggles (it shed more than two-thirds of its value since the rebrand, and layoffs and privacy tracking changes cut into its core advertising business), it confirmed plans to devote 20% of "overall costs and expenses" to Reality Labs in 2023, splitting half of that between VR and AR efforts. Though Meta currently dominates headset shipments, competitors to Meta's Quest 2 are around the bend from HTC and Apple. And VR legend John Carmack left the company to start his own venture, citing inefficiencies stifling Meta's execution.

As much as Meta hopes to be the owner of the metaverse, a number of other initiatives launched last year to move toward a more interoperable vision, namely the formation of the Metaverse Standards Forum. Announced in mid-2022, this forum brings leaders like Microsoft, Adobe, Nvidia, Unity, and Meta together with engineering and developer standards bodies like IEEE and W3C to coordinate interoperability efforts. (Apple was notably absent.)

Dystopias are not meant to be playbooks, even if tech's leaders look to them for inspiration. Tech leaders and brands alike should learn from the problems that plague today's internet landscape as they lay the groundwork for the internet's next embodied interface; issues like misinformation, harassment, data privacy, and surveillance capitalism will only be exacerbated in new realities. And new realities interfaces stand to disrupt our sense of time, space, and our relationships with each other; for that reason, regulators in both the US and the European Union have already put "metaverse" on the policy agenda. Whether it's the visceral, immersive VR experience or an overlay of information on the street, the stakes are even higher when the digital and physical worlds merge.

There's no question that any future-oriented business leader should pay attention to the computing interfaces and form factors slated to supplant the smartphone, though we have not yet reached the iPhone-comparable moment that makes metaverse utility obvious and its adoption inevitable. The game-changing applications for new realities have yet to be identified—and they're not going to be about solving Zoom fatigue. For now, efforts focus on experimentation and incremental improvements to devices, and we're dependent on consumers' willingness to wear bulky headsets and play in cartoonish playgrounds. But now's the time for learning and for building the foundation for platforms to come. As tech analyst Benedict Evans has written, asking whether we need a metaverse strategy today might turn out to be like asking whether we needed a mobile strategy in 2002 or 2005.

In short, the future of new realities is here. It's just not interoperable—yet. And it still might make you seriously nauseated. Hold on to your headsets as the lines between worlds vanish into the horizon.

STATE OF NEW REALITIES IN 2023

When will new realities disrupt you?

For most industries, the disruptions posed by new realities technologies are 5 to 10 years on the horizon. Two-thirds of US executives told PwC for a May 2022 survey that their companies are actively developing metaverse plans, and 82% of executives expect the metaverse to be a part of their business activities within three years. Future Today Institute recognizes the convergence of new computing interfaces, synthetic media and generative AI, and digital identities and assets as the next embodied, spatial iteration of the internet.

Several factors are driving the momentum of new realities trends and the probable timing of any given industry's disruption:

Interoperability: The metaverse, at least as many analyst firms have defined it, is many years out. What we have today are corporate-owned walled gardens. While consortiums have cropped up to address the shared protocol and standards issues, it will be 5 to 10 years before agreed-upon standards make navigating the metaverse as seamless as typing in a URL. Gartner puts a 10-year horizon on a truly interoperable vision of the metaverse. Still, its analysts say that within a few years, one in four people will spend at least an hour a day in the metaverse. Gartner also foresees 30% of the world's organizations offering metaverse products and services by 2026.

Tech stack limitations: For VR and AR to reach wide-scale adoption, or to come anywhere close to replacing familiar smartphone, tablet, and laptop screens, we will need to see significant improvements in form factor—wearable comfort, battery life, and display technology. VR headsets are somewhat technically easier to accomplish because they assume relatively stationary use, are easily tethered, and can still create immersive experiences at a relatively accessible consumer price point. AR glasses and contact lenses are much further out, even with a decade of work put in since Google Glass. Still, R&D and innovation labs can wade into these waters and imagine what's possible as the hardware rapidly improves over the coming two to five years.

Consumer vs. enterprise applications: Immersive gaming worlds of today—even in 2D—are very much the proto-metaverse. Entertainment, gaming, and retail experiments in digital worlds are low-stakes opportunities to reach younger, digitally savvy audiences. Enterprise applications are more costly investments, though partners like Siemens and Nvidia are building out the tech stack for enabling early use cases for cities, manufacturing, and energy modeling, and early pilot cases are proving the potential for dynamic modeling and management of digital twins.

Adoption curves and demographics: Poor user experience given bulky hardware and technical glitches, as well as limited quality and content offerings, are cited as the top barriers to mass adoption of consumer XR, though those barriers are lowering each year. Higher-income, well-educated, and tech-savvy consumers will be the near-to-medium-term demographics populating new realities. Scholars and critics note concerns that this adoption curve will only further exacerbate existing digital divides.

Production readiness: Virtual gaming economies are mature and don't require headsets. Fortnite CEO Tim Sweeney has said we shouldn't hold our breath for Fortnite VR anytime soon—rapid run-through gameplay just doesn't work yet in VR. But 2D gaming is where all the experimental activity has been focused in recent years, exploring what's possible for virtual goods economies and brand experiences where Gen Z spends its time. Look to brands like Walmart, Forever 21, Claire's, Nike, Gucci, and even Chipotle for inspiration for near-term experimentation. Synthetic media and generative AI have exploded in the last year, but many kinks need to be worked out before commercial applications are viable at scale. While platforms like OpenAI's Dall-E and ChatGPT have launched in research mode, APIs (application programming interfaces) for their generative models offer enterprising developers the opportunity to adapt them to new applications, regardless of whether bias is mitigated and guardrails for responsible use are in place. Creative industries should absolutely be experimenting and capturing opportunities; synthetic media disruptions will come quickly and will dramatically reshuffle creative resources and skill sets. If the hottest role of the 2010s was data scientist, the next hot role will be generative-prompt curator.

Hype cycles and the SV narrative: The media cycle's shift toward crypto, Web3, and the metaverse over the last year is a victory for the tech industry, which worked to redirect attention toward the next thing rather than toward what they've already built and broken. Andreessen Horowitz's "it's time to build" call spurred an influx of VC funding and startup exuberance. Some of that froth has blown off as headwinds shifted in the second half of 2022. Most XR professionals see the present challenges as a short-term refocusing on fundamentals and more strategic bets.

STATE OF NEW REALITIES IN 2023

Emerging Opportunities

Whatever skepticism you may have based on the limits of VR and the metaverse today, it behooves us to take tech leaders' visions and plans seriously. While not inevitable, their visions for tech's progress will certainly affect consumers, business models, and society as computing interfaces evolve into what has the potential to be the greatest shift in human computing interfaces since the smartphone.

Enhanced customer experience: Omnichannel expansion continues. Immersive realities could allow brands to create more engaging and interactive experiences for their customers: virtual tours and events, utilizing AR rendering or a digital twin to try on clothing or furniture from the comfort of one's home, or traveling anywhere at the drop of a hat with very little carbon footprint (or, for IRL trips, experiencing a digital overlay of recommendations, historical models and simulations, or just-in-time booking opportunities).

Increased efficiency and productivity: Virtual environments can support future-of-work remote collaboration and communication, increasing efficiency and productivity by creating a sense of distributed presence. Microsoft Mesh has already partnered with Meta to bring enterprise collaboration to the metaverse with a focus on hybrid co-presence. VR can create immersive learning and training experiences that put material in context or in real-time applications for industrial and manufacturing use. Synthetic media means A/B campaign and messaging tests could extend to X/Y/Z permutations with generated creative or hyper-personalized content.

New revenue streams: New realities provide opportunities to monetize virtual goods or services and to advertise in virtual and augmented overlays. Business models are sure to be disrupted, just as the first wave of digitization shifted how bits were distributed, valued, and priced.

New channels for marketing and communications: As target audiences spend more time crossing into virtual and augmented digital space, brands are looking to reach new customer segments there. You can't yet smell or taste in the metaverse, but that hasn't stopped Chipotle and Chick-fil-A from influencing hungry young gamers in Roblox.

Emerging Risks

All emerging technologies involve inherent risk. For new realities, that risk is compounded by an over-reliance on developing for early movers' platforms before universal shared standards are established.

Reputational risk is also significant in early experimentations that go awry, especially when synthetic media outputs are so variable and new interfaces so immersive and intimate. New technologies bring new behaviors and norms. Early movers can claim the frontier, but not without risking the Wild West.

New laws and regulations tend to follow once harms are better understood. Maximizing intellectual property is both the promise and the battleground for new realities as fair use, portability across worlds, and tokenization disrupt our understanding of property rights and scarcity. The US and EU have already put the metaverse on their forward-looking agenda given the consumer protection and fraud concerns brought about by crypto and Web3 grifters.

Why new realities trends matter to your organization

Future Today Institute research suggests that new realities technologies are developing into a disruptive force that represents the next immersive and embodied computing interface. By 2030, nearly every industry will have explored or adopted new modes of digital interaction with customers or their products that make use of virtual and physical space. Business leaders must gain an understanding of the promise and peril of virtual realities, augmented overlays, and the metaverse by researching and experimenting today to stay competitive and anticipate the coming wave of digital disruption.

KEY INSIGHTS

Interfaces will become more immersive as both virtual spaces and the physical world are interlaced with rich digital media experiences.

The metaverse is not a single technology, protocol, or entity; it means many different things to many different stakeholders. Get clear about expectations and interests being brought to the table.

Smart eyewear, in the form of glasses and contacts, will upend industries and interfaces designed for smartphones. New computing interfaces like headsets and glasses will take years to reach wide user adoption, but web-based standards already make augmented experiences possible using today's smartphones.

AR applications are ripe for consumer adoption because they solve for real-world convenience needs like navigation and contextual information, and yet they may be furthest away due to the technical challenges of heads-up displays, glasses, and contact lenses.

Interoperability and standards are still being worked out, but they are key to making spatial computing transferable across worlds, whether it's about a shared understanding of coordinates or transferring attributes of virtual goods and identity avatars across platforms.

People will create multiple digital versions of themselves, each tailored for specific purposes. This will lead to fragmentation—and a widening gap between who a person is in the physical world and who they project themselves to be in various online platforms.

Economic headwinds may have tempered recent exuberance over new realities, but the infrastructure work that will pave the path for future development is underway.

XR technologies pose as many accessibility challenges as they do opportunities.

Embodied, spatial presence in virtual worlds only increases the need for ethical and humane guardrails for responsible use of technology.

IMPORTANT TERMS

Augmented reality (AR)
Technology that superimposes digitally generated images, sounds, and other sensory inputs onto a user's view of the real world, enhancing or augmenting his perception of reality. Often achieved via a smartphone or tablet, which uses its camera and sensors to detect the user's surroundings and overlay digital information on top of the real-world view, AR has a wide range of applications, including entertainment, education, and training. Enterprise use cases for AR are wide-ranging, encompassing everything from monitoring supply chains and complex equipment via digital twins, to hosting hybrid virtual and in-person meetings, to providing guided AR tutorials as part of workplace training.

Avatar
A customizable representation of a person or a character in a virtual environment, such as a video game, social media platform, or virtual reality experience. Avatars can take many forms, from simple two-dimensional icons to highly detailed three-dimensional models that closely resemble the user. Users can choose their avatars' appearance, clothing, and other characteristics to create a unique digital identity.

Creator economy
The ecosystem of creators, artists, and entrepreneurs who create and sell virtual goods and experiences in virtual worlds and online communities. This can include clothing, accessories, and other items for avatars, as well as digital art, music, and other forms of content. In many virtual worlds and online platforms, users can buy and sell these virtual goods using in-game currencies or real money, and creators can earn an income from their sales. The creator economy has grown significantly in recent years with the proliferation of virtual worlds, social media, and other online platforms.

Digital twins
Digital representations of physical assets, systems, or processes that can be used to simulate and analyze the performance of these assets in a virtual environment. Digital twins are created using data from sensors, simulation models, and other sources, and can be used to optimize the design and operation of physical assets, predict maintenance needs, and improve efficiency. Digital twins can be used in a variety of industries, including manufacturing, construction, transportation, and energy, and can help organizations to better understand and optimize their complex systems and processes.

Diminished reality (DR)
Instead of adding to or enhancing one's surroundings, DR suppresses or eliminates certain visuals, sounds, or other sensory elements. DR has a range of potential applications, including for the military and medical and entertainment industries, and can be used to enhance safety, reduce distractions, or create immersive experiences. DR has existed in some form for more than a decade; one of the most ubiquitous examples is noise-canceling headphones. But as the technology matures and is developed for the audiovisual applications of smart eyewear, users will be able to target specific environmental elements to spotlight or suppress, whether it's isolating a particular speaker's words and appearance in a crowded room, or removing all advertising from view as they walk through a city center.

Extended reality (XR)
An umbrella term referring to a range of technologies that enable immersive experiences by combining the real world with digital information. XR technologies include augmented reality, virtual reality, and mixed reality, which involve the overlay, replacement, or integration of digital information with the real world. XR technologies are often used in combination, with AR and VR used for different types of experiences and applications.

Low-code platforms
Software development tools that allow users to create applications with minimal coding. Low-code platforms typically provide a visual interface and interchangeable components, allowing users to build and customize applications by dragging and dropping elements and connecting them, rather than writing lines of code. These platforms can be used by developers or by nontechnical users and are designed to be easy to learn and use.

Metaverse
A collective virtual shared space, created by the convergence of virtually enhanced physical reality and persistent virtual space, including the sum of all virtual worlds, augmented reality, and the internet. The term was coined by science fiction author Neal Stephenson to describe an environment in which people can interact with each other and with virtual objects in a way that is similar to the real world. The metaverse is made up of

IMPORTANT TERMS

the gradual convergence of evolving hardware interfaces, sensors and devices, spatial mapping and imaging techniques, and high-bandwidth wireless network infrastructure. The metaverse is not a single technology, nor is it controlled by a single centralized company or entity.

Metaverse wallet

Wallets store and manage virtual currencies, assets, and other digital items that are used in the metaverse. They can also facilitate transactions between users and enable the exchange of virtual goods and services. Metaverse wallets may be linked to external payment methods, such as credit cards or bank accounts, to allow users to purchase virtual items or currencies.

Mixed reality (MR)

Technology that anchors virtual elements to corresponding physical elements in your environment—you can still physically interact with objects and surfaces, but their appearance and reactivity may be virtually altered or enhanced. MR experiences follow the physical laws of the real world; for example, they can be occluded by physical objects, and the lighting is consistent with the environment as though they are in the same space as the user.

Non-fungible tokens (NFTs) and asset tokenization

Digital assets that represent ownership of a unique item or piece of content, such as a collectible, artwork, or in-game item. NFTs are stored on a blockchain and are unique and indivisible, meaning they cannot be replaced or exchanged for an equivalent item. Asset tokenization refers to the process of creating a digital representation of an asset, which is then stored on a blockchain and can be bought, sold, and traded like any other digital token in a digital marketplace.

Passthrough

Feature that allows users to see the real world while wearing XR headsets. Passthrough features are often implemented using a camera or other sensors on the headset that capture the user's surroundings. This allows users to see the real world through the headset while still being able to access the virtual or augmented reality experience. Passthrough features can be useful in situations where users need to temporarily switch between the virtual and real worlds, such as when they need to interact with their physical surroundings or take a break from the VR or AR experience.

Proprioception

The sense of the position and movement of the body and its parts as they relate to the virtual environment. Proprioception allows us to sense the position and movement of our limbs and other body parts without the need to look at them, and to adjust our movements in response to changes in our surroundings. In VR and other immersive technologies, it is important for avatar movement, physical interaction with virtual objects, and navigation within the virtual space. However, proprioception can be disrupted, as the body's natural proprioceptive cues may not always align with the virtual environment. This can lead to a sense of disconnection or disorientation, known as simulation sickness. Researchers and designers are exploring ways to enhance proprioception using haptic feedback and other sensory inputs to create more immersive and comfortable experiences.

Play-to-earn games

Games that allow players to earn real or virtual currency, assets, or other rewards through in-game activities, such as completing quests, leveling up, or achieving certain milestones.

Persistent virtual worlds

Virtual environments that are continuously available and maintained, even when users are not logged in. Persistent virtual worlds can be accessed by multiple users simultaneously. They can offer a wide range of activities and experiences, including socializing, gaming, and creative expression, and often have a shared set of rules and norms that govern users' behavior and interactions and provide them with a sense of community.

Six degrees of freedom (6DOF)

The ability to move in six different directions: up/down, left/right, forward/backward, pitch (up/down tilt of the head), yaw (left/right tilt of the head), and roll (rotation of the head around its axis). In the context of virtual reality and other immersive technologies, this can be achieved through VR headsets or other devices that track the user's head movements and translate them into the virtual environment. 6DOF is important for creating a realistic and immersive VR experience, as it allows users to move and look around the virtual environment in a way that is similar to the real world.

IMPORTANT TERMS

Spatial audio
Techniques such as binaural audio, ambisonics, and wave field synthesis that allow sound to be placed and moved in 3D space, creating a more realistic and immersive listening experience.

Spatial computing
Spatial computing enables immersive, interactive experiences in 3D space. Simon Greenwold defined it as "human interaction with a machine in which the machine retains and manipulates referents to real objects and spaces." Spatial computing can involve the use of sensors, cameras, and other devices to capture and interpret spatial data, and advanced visualization and rendering techniques to create realistic and interactive 3D environments. It also includes the use of standards for identifying spatial assets like position and scene descriptions.

Synthetic media or generative AI
Content that is generated or synthesized using artificial intelligence techniques, rather than being captured or recorded in the real world. Synthetic media can include text, images, audio, and video, and can be created using machine learning, natural language processing, and computer graphics. Generative AI specifically uses machine learning techniques, such as deep learning, to learn from a large data set of examples and to generate new content that is similar to those examples. Both have been used to create deepfakes, virtual characters, and avatars. However, synthetic media also raises concerns about the potential for AI-generated content to be used for nefarious purposes, such as spreading misinformation or impersonating real people.

Virtual reality (VR)
Technology that enables users to experience and interact with a simulated, completely artificial digital environment in a way that is immersive and realistic. VR can be achieved using specialized hardware, such as VR headsets, gloves, or motion platforms, which provide users with a sense of presence, embodiment, and agency, and can be explored from the first-person perspective.

Virtual worlds
Virtual worlds can take many forms, including massively multiplayer online games (MMOs), social media platforms, virtual reality environments, and online communities, and can be accessed through devices such as desktop computers, smartphones, and VR headsets.

Visual positioning system (VPS)
VPS systems can provide users with precise and real-time information about their location and orientation and can be used to enable a wide range of interactive and immersive experiences. They often use cameras and other sensors to capture images or other data about the environment, which they use to calculate the position and orientation of an object or device in relation to the environment. VPS systems can be used for applications including augmented reality, robotics, and navigation, and can be used in both indoor and outdoor environments.

Walled garden
A virtual environment or platform that is controlled and managed by a gatekeeping single entity, and that limits or restricts the ability of users to interact with other platforms or environments. Contrast walled gardens with open virtual environments or platforms, which allow users to interact with a wider range of content and experiences.

ONES TO WATCH

Andrew "Boz" Bosworth, chief technology officer and head of Meta's Reality Labs, for being Mark Zuckerberg's right-hand man and overseeing more than 20,400 people in realizing Meta's vision for the metaverse.

Andy Parsons, senior director of the Content Authenticity Initiative at Adobe, for building standards for secure content provenance to restore trust and transparency to the media.

Brittan Heller, senior fellow at the Atlantic Council and DFR Lab, and incoming affiliate at Yale University and Stanford Law School, for advocating for a metaverse 911 as a solution to governance and human rights violations in virtual worlds.

Camille François, global director of trust and safety at Niantic, for her work on responsible innovation for AR experiences.

Courtney Cogburn, associate professor at Columbia School of Social Work, for imagining Black futures in the metaverse and for her contributions to "1000 Cut Journey," an immersive virtual reality experience of racism designed to develop empathy.

Elizabeth Hyman, CEO for the XR Association, for leading stakeholders from Meta, Google, HTC Vive, Microsoft, and Sony Interactive Entertainment in responsible innovation, and for influencing emerging policy that addresses immersive environments.

Grace Boyle, multisensory XR storyteller at The Feelies, for developing immersive stories that explore the full range of human senses, arguing that we have not five but perhaps upward of 33 different senses.

Ioana Matei, head of emerging and immersive technologies at Procter & Gamble, for exploring the future of retail and immersive brand experiences and for co-founding Women in Immersive Technologies with the objective of lifting up other women in the industry.

Jensen Huang, CEO and president of Nvidia, for envisioning the Omniverse platform and developer ecosystem to build the industrial metaverse and a clear path to metaverse revenue. And for building the ambitious digital twin Earth-2 to model and combat climate change.

Jeremy Bailenson, founding director of the Virtual Human Interaction Lab at Stanford University, for conducting his innovative "Virtual People" course in VR, and for creating the DICE model for evaluating what experiences take full advantage of VR affordances—that is, situations that would otherwise be dangerous, impossible, counterproductive, expensive, or rare in the real world.

Joanna Popper, chief metaverse officer at CAA, for helping talent clients understand and explore emerging technologies' impacts on content creation, distribution, and community engagement.

Jonathan Lai, general partner at Andreessen Horowitz, for cofounding the A16z Games One Fund, which invests in games as social networks, AI-first games, and Web3 creator economies; it has already invested in Ready Player Me for its interoperability potential, which would allow players to bring their digital identities and assets wherever they go.

Joseph Jerome, policy manager at Meta's Reality Labs and former director of Platform Accountability and State Advocacy at Common Sense Media, for his work on what privacy and autonomy look like in emerging, immersive digital worlds.

ONES TO WATCH

Julie Larson-Green, CTO at Magic Leap, for restructuring and supporting culture change to revive the headset company for the enterprise market.

Kavya Pearlman, founder and CEO of XR Safety Initiative, for promoting privacy, safety, security, and ethics in immersive environments through the creation of a standards body and Metaverse Safety Week.

Dr. Louis Rosenberg, CEO of Unanimous AI, for advocating for basic immersive rights for a safe metaverse in his work for the Responsible Metaverse Alliance and the XR Safety Initiative.

Dr. Mar Gonzalez-Franco, research scientist at Google Labs, for her research on human behavior and perception, and for prototyping immersive devices like AR glasses that translate audio to text.

Micaela Mantegna, TED fellow and video game lawyer, for her work covering digital rights, virtual worlds governance, and intellectual property in the metaverse.

Nelly Mensah, vice president of digital innovation at LVMH, for launching luxury brands into the metaverse.

Pat Pataranutaporn, researcher at MIT Media Lab's Fluid Interfaces group, for his research on AI-generated characters and synthetic virtual humans.

Dr. Rabindra "Robby" Ratan, associate professor at Michigan State University's Department of Media and Information, for his research on the "Proteus effect"—the notion that avatars with certain characteristics can influence behavior.

Rebecca Barkin, president of Lamina1, for spearheading Neal Stephenson's Layer 1 blockchain that incentivizes makers, respects the agency and privacy of patrons, and is purpose-built to sustainably power the new economy on the open and interoperable metaverse.

Rick Robinson, vice president of innovation and startup engagement at AARP, for exploring how immersive technologies will help seniors beat loneliness and isolation.

Sebastian Brauer, senior vice president of the metaverse at Crate & Barrel, for bridging the physical and digital worlds through design thinking, collaboration, and creativity.

Sophia Dominguez, head of camera platform partnerships at Snap, for introducing new contextual lens scanning features and making AR lens creation easy for brands.

Timoni West, vice president of emerging tools at Unity, for envisioning the spatial computing tools developers will need to create digital twins for the industrial metaverse and making those tools even more accessible.

Yacine Jernite, machine learning and society lead at Hugging Face, for helping shift how creators are treated by AI researchers in training data sets for community-driven machine learning models.

Zvika Krieger, consultant and former director of Responsible Innovation at Meta, for developing strategies to effectively anticipate and mitigate potential harms in the metaverse.

NEW REALITIES & APPLICATIONS

TRENDS

NEW REALITIES AND APPLICATIONS

VIRTUAL ASSETS

As virtual environments evolve, users are increasingly interested in acquiring digital possessions as investments and to enhance their profiles and experiences in the metaverse, and VR stylists have emerged to cater to them. New technologies bestow these virtual items with the same qualities that make physical possessions valuable—uniqueness, scarcity, provenance—and provide a framework for digital ownership. Virtual items, from clothing to furniture, tools, structures, and land, can be created with 3D-rendering platforms, game engines, and other digital design applications, but for the item to exist as a possession in the metaverse, it must retain certain unique qualities beyond its aesthetic design. One Gucci handbag sold for more on Roblox than it costs IRL. Blockchains can be used to track a virtual item over time, authenticating it and logging its history as it changes hands, providing a basis for its valuation. NFTs can provide evidence of ownership for a virtual item or piece of digital content, even if it is easily reproducible with a right-click to save. Virtual possessions are evolving from art, collectibles, fashion, and real estate to items with unique added functionality in the metaverse, like art-related NFTs that pay dividends to the owner when the related real-world work is sold or consumed, or that grant access to exclusive virtual environments. Virtual goods are also pushing the boundaries of fair use. Mason Rothschild's MetaBirkin NFTs, inspired by Van Gogh, Rothko, and Kusama, sold for up to the equivalent of $42,000. The NFT creator was later sued by Hermès, maker of the real-world Birkin bags, which cited trademark infringement, trademark dilution, and cybersquatting.

DIGITAL REAL ESTATE AND THE NEW "NEIGHBORHOOD"

Early in Web 2.0, people were selling pixels on websites and trying to figure out how to monetize digital spaces. The answer turned out to be banner ads. Now, as we move into the next evolution of digital spaces, we're doing it again—this time (for now) as digital real estate. Land in the digital world is being zoned, sold, and developed as people settle into their virtual lives. Though the metaverse is arguably infinite, shared spaces within it can have more defined boundaries, and many emulate traditional cities and towns. Some of these spaces are becoming popular hubs for virtual communities, gaming, commerce, and culture, giving rise to a digital real estate market in which users exchange currency to rent and own virtual property. In an episode of HBO's "How To With John Wilson," the titular documentarian interviews a man who works as a "land baron"—essentially a virtual real estate agent—in the metaverse platform Second Life. The man explains how his avatar helps users tour and select properties in the platform's virtual world, collects monthly rents, and even evicts delinquent tenants.

As metaverse platforms attract more users (recreational ones as well as those with business interests) and integrate more functionality, new "neighborhoods" are taking shape around the same criteria that define their real-world counterparts: like-minded communities, property values, zoning codes, gentrification, strategic retail locations, and locally accessible services and cultural resources. Digital real estate saw a boom as the concept of the metaverse rose in popularity: In 2021, a new record was set when digital real estate investors and developers Republic Realm purchased a plot in metaverse platform The Sandbox for $4.3 million. Soon after, an anonymous user reportedly paid $450,000 to purchase a plot of virtual land in The Sandbox next to Snoop Dogg's virtual residence, "Snoopverse." The market has since cooled, showing that real estate in the nascent metaverse is subject to the same opportunities and pitfalls of any real estate rush. Savvy buyers may be able to snap up affordable properties now that eventually skyrocket in value, but this volatile market is best suited to investors with a high risk tolerance. For now, investors may just be buying empty lots on the Vegas Strip in the middle of a digital desert.

FUTURE OF WORK

New realities platforms have the potential to change how we work together. Corporations are already seeing the benefits of using VR for onboarding and training, especially for demonstrating complex soft skills, or for safety trainings that would otherwise be prohibitively expensive or dangerous as a 2D learning module (think: active shooter response). Verizon has used VR to develop empathy and de-escalation skills in call center associates. Training platform Strivr has partnered with Bank of America, Walmart, and even the NFL to develop immersive VR training modules. VR simulation has the potential to create a safe container for learning and making mistakes in fields like nursing. Meta is betting on building the corporate metaverse, based on its $1,500 Meta Quest Pro price point

NEW REALITIES AND APPLICATIONS

and its partnership to integrate Microsoft Teams and Office 365. But VR veterans like Jeremy Bailenson have said that VR just isn't that good for knowledge work—email is just fine in two dimensions. While not all workplace activities will get virtually mediated, it's more likely the metaverse will play a role in co-presence for virtual meetings, taking the videoconferencing strides made during the pandemic to the next level of immersive collaboration. That could mean XR devices might have a reverse-consumerization adoption trajectory. BlackBerry crawled so the iPhone could run.

CONNECTED WELLBEING AND VR ASSISTED THERAPY

From prescription gaming to VR pharmacies, digital therapeutics are earning medical backing—cueing up a new class of meta-medicine that brings the digital dimension to physical medicine. North-Star Care has developed a program for treating alcohol use disorder, allowing virtual meetings with doctors and connections to anonymous peer mentors in the metaverse. AARP's Innovation Labs is investing in supporting senior care applications of VR; VR studies on people living with dementia saw improvements in their affect, stress, and overall quality of life while reducing caregiver burden. For eating disorders, VR exposure and reference frame shifting have been shown to have a potential advantage over cognitive-behavior therapy treatments. Children's hospitals have used XR for distraction and pain management, reducing the need for anesthesia and physical therapy. VR also has potential to intercept disruptive research in psychedelics, facilitating hallucination-like states in a controlled setting to improve even non-responsive depression and PTSD.

FORENSIC AR/VR

Crime scene investigations are evolving with the help of augmented and virtual reality tools, allowing trainees and analysts to explore simulations and recreations of remote, destroyed, compromised, or artificially generated crime scenes. Using the same medical imaging training data sets and machine learning, AR-assisted autopsies could help diagnose cause of death and identify victims. Over the past decade, the Zurich Institute of Forensic Medicine has experimented with AR applications using the Microsoft HoloLens to enhance its forensic autopsy procedures, and Dutch police trialed an AR system to allow forensic scientists to remotely annotate crime scenes. Industrial3D has created a virtual training game on DNA extraction for the University of North Texas's Health Science Center and Center for Human Identification. Forensic Architecture, a research agency based at Goldsmiths, University of London, has used VR technologies to digitally model 3D environments as it investigates human rights abuses and then shares its work with parliamentary inquiries, citizens' tribunals, and the UN.

> We know [VR] is good enough. We know it can solve real problems that people have, and the roadmap that we have is just so exciting. Augmented reality is the one where the question is, when is it good enough? When is the thing that you're looking at the Palm Pilot or the Trio, and when is it the iPhone?

ANDREW BOSWORTH, CTO, META

TRENDS

METAVERSE INFRASTRUCTURE

METAVERSE INFRASTRUCTURE

INTEROPERABILITY AND THE OPEN METAVERSE

Is the metaverse here? That depends on your interpretation of a key factor: interoperability. Platforms have not been interoperable from the start—gaming graphics engines Unreal and Unity followed differing x, y, and z coordinate structures for mapping 3D spaces. Those who subscribe to a vision of the metaverse that becomes the next iteration of the internet believe there needs to be shared standards, protocols to make traversing the metaverse as easy as typing in a URL. Web3 ideology and rhetoric has centered on the decentralization and portability of experiences, identities, and properties, regardless of the platform from which they originate. Last year, the Metaverse Standards Forum was established, with players from Microsoft, Meta, Unity, Fortnite developer Epic Games, Nvidia, and Qualcomm, as well as Ikea, Wayfair, Khronos Group, Lamina1, and others signing on to establish a set of shared protocols for emerging interfaces and experiences. The Linux Foundation also announced the creation of the Overture Maps Foundation along with Amazon Web Services, Meta, Microsoft, and TomTom to standardize open-source map data with a global entity reference system. Standards bodies are working through universal scene descriptions, first established by Pixar and now promoted by Nvidia's Omniverse cloud and Lightship Augmented Reality Developer Kit. The Open AR Cloud Association is advocating for interoperable standards for visual positioning and scene understanding and modeling to connect a persistent spatial experience with content that occupies the same physical space no matter what angle it is being viewed from, and remains present in its digital form regardless of whether a particular viewer is watching. These standards could mean that virtual spaces could translate across applications, whether on a movie set or in a branded Peloton course. Sci-fi author and coiner of the term "metaverse" Neil Stephenson—despite his dystopian narrative—is all in on the open vision. His Lamina1 fund is focused on opportunities to build an open, decentralized, and creative version of this next computing interface. Even Meta's Mark Zuckerberg has acknowledged that his long-term vision relies on an open ecosystem of partners, including Microsoft, as an entrée into the enterprise productivity tool market.

BROWSER-BASED AR

Many AR experiences available today require users to download an app to their device—or buy a new device altogether—but WebAR is a growing field in which augmented reality experiences are built using JavaScript and WebGL to make them directly accessible through a browser. This successfully sidesteps barriers to entry like data storage limits and device compatibility issues that might hinder an app-based experience, effectively helping AR content (including popular consumer use cases like virtual try-ons for fashion and beauty, interior design mockups, and spatially enhanced gaming) reach a broader audience more efficiently. WebAR startup 8th Wall, acquired by AR pioneers Niantic in 2022 and set to be integrated into its Lightship development kit, has enabled AR mobile experiences for brands like Netflix, Dior, Lego, and Porsche. Browser-based AR will enable near-term augmented experiences as long as the smartphone remains the dominant consumer interface. Brands looking to experiment today can deploy to a massive user base with high engagement, dwell time, and conversion rates.

MAPPING THE METAVERSE

TRENDS

MAPPING THE METAVERSE

AR LENSES AND FILTERS

AR lenses overlay real-time digital information onto the physical world. The simplest versions are social media filters and lenses, which often map details to faces. Snap says 75% of its community engages with AR every day, and usage of Snap lenses is up 85% year over year. HBO partnered with Snap to generate both a selfie and a landmarker lens to promote "House of the Dragon," allowing virtual dragons to take to the skies of your neighborhood. Snap recently announced that it is introducing new tokens for lenses and filters to allow 300,000 creators and developers to monetize their AR work. Taking advantage of new LiDAR sensors in smartphones, brands like Ikea have developed more advanced AR filters to virtually place and model their furniture in your home, even allowing you to delete existing furniture and replace it with 3D models of a Poang chair. Lenses can even make sense of a pile of Legos to identify individual bricks and suggest blueprints for projects that make use of your collection.

DIGITAL SPACES

Online experiences are beginning to take place in virtual 3D environments that emulate those in the physical world, from computer-generated households and workplaces to event venues and retail shops. These digital spaces will be foundational in the metaverse as our online activities increasingly resemble our offline lives. One of the first sectors to create shared online digital spaces is gaming, with sprawling interactive realms built to simulate environments, landscapes, and structures theoretically feasible in the real world. These gaming environments have recently diversified their offerings to users, with platforms like Roblox and Fortnite hosting virtual concerts with big-name artists. In the business realm, Microsoft previewed its Mesh product, which will allow users to connect via the company's Teams communication platform by entering a 3D-rendered virtual workspace rather than a standard video call. By applying mixed reality technology, Microsoft Mesh can also link elements of the virtual workspace to physical features of users' actual surroundings, creating a hybrid physical-virtual environment. Soon digital spaces will be accessible for a broader range of activities, allowing users to have their avatars browse the shelves of virtual shops, enter virtual doctors' offices for remote consultations, and attend classes in virtual lecture halls, all with 3D spatial environments.

LIMINAL SPACES

Extended reality is blending the physical and digital realms, transforming real-world spaces into interactive environments. These new experiential spaces make use of sensors, smart cameras, real-time mapping, augmented reality, and other technologies so that digital elements can respond to people as they move. For example, Artechouse produces interactive installations at its Miami Beach, New York City, and Washington, D.C. locations. In a spring 2022 exhibition, an artist used generative algorithms to create audiovisual paintings—imagine swirling colors and sound—while visitors watched and listened. The Shed partnered with High Line Art in New York City to develop "The Looking Glass," where visitors used an app to see virtual statues dotting the High Line's walkway, and interactive soundscapes turned on as visitors moved past.

PARALLEL REALITIES

New screen and spatial tracking technology could make it possible to show personalized information and wayfinding details in context. Partnering with Misapplied Sciences, Delta has piloted a "parallel reality" departure board at Detroit Metropolitan Airport. Travelers scan a digital boarding pass as overhead sensors track their presence and position and relay personalized flight details on a multi-view pixel display; the display can simultaneously project different colors of light in different directions depending on where the viewer is standing. The display technology, combined with beacon tracking, could create the "Minority Report" vision for contextual advertising and wayfinding in stadiums, shopping centers, and more.

INDUSTRIAL METAVERSE AND DIGITAL TWINS

The US Army Research Laboratory has set out to build One World Terrain, an up-to-date, high-resolution 3D map of the world that can be used for positioning and navigation on the ground in territories where GPS cannot be accessed. The nearly $1 billion project, contracted to a subsidiary of satellite operator and 3D-mapping company Maxar Technologies, is central to the Army's Synthetic Training Environment, a hybrid physical-digital interface for soldiers to run training missions in immersive virtual settings that mirror the real world. A 2022 World Economic Forum report on digital twin cities analyzed synthetic clones of urban environments and infrastructure designed to facilitate

MAPPING THE METAVERSE

civil engineering and city planning. Examples include projects to solve for traffic management in Kunming, China; carbon reduction in New Mexico; and cost-efficient construction in Rennes, France. (In the future, these digital twin cities could be populated with virtual citizens in avatar form as they evolve into metaversal environments.) The island nation of Tuvalu has announced plans to upload its digital twin to the metaverse as a way to preserve its culture and land boundaries as rising sea levels threaten to submerge it. Companies like Coca-Cola, Unilever, AB InBev, and General Motors are exploring industrial metaverse tools to model and optimize production. Lowe's is building digital twins of its stores to manage the customer experience and overlay inventory details for associates. Nvidia President Jensen Hwang is banking on the inevitability that the economy of the industrial metaverse and digital twins will eventually surpass that of the real world. Support from industrial digitization partners like Siemens, Nvidia, Unity, and Microsoft are helping governments and industrial companies alike to map and model their complex systems into digital twins.

HOLOGRAMS

Holograms are light field recordings that, when reproduced, can appear as static or dynamic three-dimensional visuals. The term is also more generally applied to any image that is rendered to appear in 3D. The accurate digital reproduction of faces, bodies, and other complex structures in dynamic 3D form is critical to the evolution of AR and VR in the metaverse, and holograms, variously combined with deepfake technology and synthetic media, may soon inhabit our everyday environments. Holograms have been used to produce concert tours featuring bygone stars in virtual form, and may soon allow production companies to draw popular synthetic media characters, celebrity standins, brand spokespeople, historical figures, and lost loved ones out of our screens and into our spatial environment. Biggie Smalls performed in the metaverse in 2022. In the medical field, holographic mapping can provide doctors with a 360-degree view of a patient's internal organs, vessels, bones, and tissue, and assist with diagnostics and surgeries, with multiple apps already approved by the US Food and Drug Administration. As this technology evolves, it may be used to display elements of the metaverse without users having to wear smart glasses. Google's Project Starline creates a very real sense of physical co-presence in a bespoke chat booth, and is currently being tested with select enterprise partners to connect remote offices. It sounds simple, but Google's research paper highlights the many challenges involved in tricking your brain into thinking a real human being is sitting just a few feet away from you. The image needs to be high-resolution and free of artifacts, but it also needs to look right relative to your position in the booth. The audio system needs to make it seem like the source of sound is coming from the person's mouth. People who have tried Starline say it's one of the most impressive tech demos ever. Google has found that people using Starline focused 15% more on who they were talking to in the booth compared to on a traditional video call, and that conversational memory recall was 30% better.

HOLOGRAPHIC DATA STORAGE

Though still in the R&D stage, holographic data storage is a promising potential technology for storing data in the volume of the recording medium, rather than on the surface, as in optical and magnetic data storage. In theory, this creates a new form of ultra high-density data storage. In the case of Microsoft's Project HSD, launched in 2020, the proposed holographic storage device incorporates a crystal through which light can be broadcast to create a range of unique data-bearing holograms, or "pages." Slight adjustments in the angle of light broadcast through the crystal illuminate entirely different data pages, making the format space-efficient, and UV light can be used to wipe holographically stored data, making the format indefinitely rewritable. The technology, if successfully developed, could greatly improve the efficiency of data storage infrastructure, and Microsoft intends to use holographic storage devices as components of its Azure cloud service.

VOLUMETRIC VIDEO

A pivotal technology for generating XR content in the metaverse that emulates real spaces and forms, volumetric video is a method of capturing dynamic environments and figures in 3D. Due to the increase of use cases for the technology as more companies and industries turn their attention to the metaverse, the global volumetric video market is expected to grow 10x by 2030, reaching a value of nearly $21 billion. Volumetric

MAPPING THE METAVERSE

video can be viewed on either a screen or an XR device; while viewers of 360-degree video can rotate their perspective and see the full scope of their surroundings from a fixed point, volumetric video allows viewers to move around their subject, viewing it with depth and from all angles. Microsoft's Mixed Reality Capture Studios are an international network of certified facilities for capturing volumetric video intended for MR applications. Once smart eyewear is the norm, we will come to expect content to be experienced volumetrically, rather than with the flat perspective offered by smartphone, tablet, and personal computer screens.

SPATIAL AUDIO

Just like volumetric video gives perspective and depth to visual content, spatial audio offers an immersive or omnidirectional soundscape that can react and adjust to the listener's positioning in real time. Whether implemented via sensor-equipped speaker systems or head-tracking earphones, this technology is central to creating lifelike sensory experiences in XR and the metaverse. In 2022, spatial audio platform Spatial Inc. piloted a project in partnership with custom sound engineers Made Music Studio to create site-specific sonic workplace atmospheres to boost mood and productivity as more employees returned to in-office work, and teamed with therapeutic audio service HealthTunes to install immersive audio "wellness rooms" in hospitals to help health care workers relieve occupational anxiety. Spatial also collaborated with the National Geographic Museum on an experiential Mount Everest exhibit, which situated visitors amid 3D-oriented sounds like a whirring helicopter and the heavy breathing of a nearby climber, and with experiential art company Meow Wolf for a South by Southwest installation featuring a variety of sculptural "art islands," each with its own unique soundscape.

Immersive audio content can be captured specially for spatial transmission or retroactively remixed for immersive formats. In 2022, David Bowie's longtime producer Tony Visconti arranged spatial audio mixes of a selection of the late singer's albums in partnership with Sony's 360 Reality Audio branded format, which is available on streaming services Tidal, Deezer, and Amazon Music HD. Spatial audio will become more commonplace, especially in entertainment, hospitality, health care, and workplace training. It'll also be a component of immersive audiovisual content in the metaverse, but in the meantime younger audiences have taken note of the format and its value—a 2022 survey from interactive streaming platform Agora.io found that four out of five Gen Z consumers are willing to pay a higher price for spatial audio–compatible headphones.

SPATIAL DISPLAYS

Spatial displays offer the magic of virtual reality without having to strap on a head-mounted display. Instead, a flat screen projects objects in what looks like a hyperrealistic, three-dimensional diorama. Examples like Sony's Spatial Reality Display use high-speed face- and eye-tracking cameras to detect the position of a viewer's eyes in real time. A video generation algorithm responds to the viewer's eye movements, while tiny lenses deliver stereoscopic images to each eye. Debuted in 2020 and featuring a dedicated software development kit supporting Unity and Unreal Engine, Spatial Reality Display is currently aimed at designers, architects, and marketers. Leia Inc., which produces spatial display monitors and tablets, is developing technology through which images appear to protrude toward the viewer beyond the plane of the screen, heightening the 3D effect, and devices by Looking Glass Factory forego eye tracking and instead feature up to 100 preset vantage points, allowing for group viewing without sacrificing the spatial perspective. As spatial displays improve and mature, they will provide inclusive XR experiences without requiring personal devices to view dimensionally rich content for consumer applications, whether in cars or on medical screens.

> All I'm asking for is some reassurance that I can buy a headset and spend an hour or two using it without feeling like my whole day is ruined afterward.

SAMUEL POLAY, TECH WRITER

HUMAN INTERFACES

TRENDS

HUMAN INTERFACES

HMDS, VR HEADSETS, AND SMART HELMETS

Head-mounted displays (HMDs), which offer more robust, immersive functionality than smart glasses but are too cumbersome and restrictive for casual use on the go, are more commonly worn in controlled workplace environments or for relatively stationary entertainment and gaming. With Meta's acquisition of Oculus, it has dominated 90% of the global market share for VR headsets, but that won't last long as others enter the market. The US Army could spend upward of $21 billion deploying Microsoft's customized version of the mixed reality HoloLens Integrated Visual Augmentation System over the next decade. Smart helmets, which are protective headwear integrated with AR visors and other connected technologies, have been available to US Air Force pilots for years—the F-35 helmet, for example, is equipped with noise-canceling headphones, night vision functionality, and a projector that can broadcast live video on the inside of the helmet's visor. Smart helmets like the Crosshelmet for motorcyclists are now available on the consumer market as well, offering features like AR navigation displays and voice assistant technology. Expect to see Apple's entrance in the near term, which may make consumer VR headsets even more palatable to a wider market beyond hardcore gamers.

SMART GLASSES

If the metaverse is our future, smart glasses will be our ideal entry point for heads-up displays. Avoiding the bulk of immersive VR headsets, smart glasses will resemble traditional eyewear with an added overlay of digital information on the world. Equipped with audio technology, cameras, and eventually smart lenses capable of displaying complex, dynamic visuals to the viewer, smart eyewear is poised to supplant the smartphone as the primary personal device. Early-entry smart eyewear is already on the market, incorporating technology like voice assistants, touchpad surfaces, video and photo capture, and bone conduction audio, which allows users to take calls and hear music and voice messages without putting hardware directly in their ears. These early-generation examples include RayBan's Stories, made in collaboration with Meta, and Amazon's Echo Frames, which as they become more familiar in the marketplace could potentially encourage early adopters who don't otherwise wear glasses to try them out as wearable smart devices. Lumus demoed its waveguide technology for lens projection at CES 2023. In 2022, Chinese MR company Nreal introduced its smartphone-pairable Nreal Air AR glasses, which lack cameras but equip the wearer to view and control multiple resizable windows of content projected using micro OLED technology, all housed in frames that weigh less than 3 ounces. Longstanding AR company Vuzix recently launched its Blade 2 smart glasses, intended for industrial and enterprise use, that can project virtual instructions for workforce tasks and allow wearers to livestream their field of vision to a remote audience, among other features. AR glasses are a few years out, however. Meta, Snap, and Apple continually delay launch dates, opting to hone the product form factor by giving headsets to the developer community before commercial launch to avoid the legacy of Google Glass.

SMART CONTACT LENSES

Smart contact lenses, embedded with sensors and electronic components, can display text and images. Some can make real-time adjustments to help people with presbyopia (the eyes' loss of ability to focus on very near objects, such as restaurant menus) or help diagnose diabetes and glaucoma by monitoring intraocular pressure within the eyes. Mojo Vision demoed the first functional AR contact lens in June 2022. Partnering with a host of companies, including Adidas (running), 18Birdies (golf), and Wearable X (yoga), Mojo Vision is developing a new type of wearable interface for sports training. Runners could see their metrics, such as pace and distance, in their field of vision without having to glance down at a watch. Golfers could see the angle of their club and likely trajectory of the ball. Innovega is developing disposable contact lenses in combination with smart glasses to aid the visually impaired. InWith Corp. developed a soft contact lens that connects wearers to important, real-time information that they would normally try to find on their phone while driving—such as speed limits and maps—to offer a safer option. The company is also developing a soft contact lens that could eliminate the need for multifocal lenses and reading glasses. This category's compound annual growth rate is expected to rise to 9.8% through 2027. Smart contact lenses will take some time to get to market. Mojo recently announced its near-term pivot away from its AR contact lens to focus on micro-LEDs due to tight capital markets.

HUMAN INTERFACES

Smart contact lenses must gain FDA approval before heading to market, but once they do, there could be a profound impact on athletics and personal training, as wearers gain a potential competitive advantage over others. Sports leagues and competition hosts will need to determine whether they should be allowed during competition. Smart contact lenses are a new interface—which means that content creators, game developers, and UX designers will have an entirely new playground to explore.

VOICE, GESTURE, AND NEURAL INTERFACES

If physical buttons and screens become a thing of the past, how will we control and communicate with our devices and the virtual world around us? The proliferation of voice assistants, from Google Home to Amazon Echo, in households across the world represents more than just a new level of convenience for families and individuals. The devices are also a method of capturing massive amounts of voice data to develop the next generation of voice AI, which is expected to understand nuanced language and communicate far more fluently, and allow users to interact with devices and virtual interfaces hands-free. In addition to voice commands, touchless interfaces will be navigated through gesture, where a user's physical movements are tracked and interpreted to control a device or projected display. Instead of dragging a fingertip across a physical screen to browse content, for example, users could motion with their head or wave their hand in the space in front of them and have their smart glasses scroll through a virtual display accordingly. Meta's Quest Pro, in addition to touch controllers, also recognizes hand gestures like pinch and zoom. Meta also acquired CTRL-Labs to work on haptic gloves and wristband inputs to utilize electromyography in capturing typing on an invisible keyboard. Even further out, R&D efforts are exploring direct brain-computer interfaces such as Elon Musk's Neuralink and Synchron, backed by Bill Gates and Jeff Bezos, but these devices face years of further development and FDA approval, not to mention user trepidation about the ethics, health, and security risks of direct interfaces.

XR ACCESSIBILITY

While new realities promise to make exploring the world more accessible to people like seniors with low mobility, XR interfaces pose a number of accessibility challenges. Even common corrective lenses can get in the way of today's headset displays. One disability advocate with muscular dystrophy described her experience touring the Anne Frank House: "I got to a part where I had to mimic opening a door, but there was no way I could do it with the controllers," she says. "Why couldn't there be an option to open the door with the press of a button? I understand the need to feel immersed, but I also can't open a door in the real world, so it just ends up locking me out. Literally." A W3C working group has begun creating XR Accessibility User Requirements. Developers need to work with disabled, blind, and neurodiverse people to better understand how metaverse spaces can be made accessible from the beginning.

MOTION SICKNESS AND VR NAUSEA

Motion sickness and nausea are still significant barriers to entry for widespread consumer and industrial adoption of VR. Meta's Quest Pro users have noted that the passthrough features and optional light-blocking blinders have made risk of nausea and disorientation more acute. Proprioception disorientation—the uncanniness of experiencing your limbs where you don't expect them to be relative to the rest of your body or spatial position—is one of main causes of discomfort in VR. It's the main reason we don't yet have legs in Meta's Horizon Worlds. Gamers and soldiers alike have complained of headaches, eyestrain, nausea, and disorientation even after brief use of headsets. FTI researchers didn't make it past the Quest Pro setup without having to lie on the floor of the bathroom in a cold sweat. Toby Shulruff, senior technology safety specialist at the National Network to End Domestic Violence, warns, "As we go from 'always on' to 'always in,' the constant immersion may cause physical, psychological, emotional, and spiritual effects including stress reactions, headaches, disturbed sleep, and detachment." And it's not just nausea—using VR in particular also presents risk of side effects such as dissociation and derealization. VR developers and hardware companies will need to come up with better warnings, guidance, and trauma-informed VR aftercare practices to make spending any time in the metaverse physically and mentally sustainable for many users.

DIGITAL IDENTITIES SYNTHETIC MEDIA & GENERATIVE AI

TRENDS

DIGITAL IDENTITIES, SYNTHETIC MEDIA, AND GENERATIVE AI

AVATARS AND AVATAR PORTABILITY

Avatars are virtual representations of users in digital platforms. As these platforms play a greater part in people's everyday lives, avatar portability—the ability to seamlessly transition an avatar among platforms built on different software or by different companies—will be key to creating a cohesive and uninterrupted user experience. You might think of an online profile picture as the predecessor to an avatar, representing users and appearing alongside identifying information, posted content, or a log of their actions within a platform. Avatars add depth to this representation, often as an animated humanoid form rendered in three dimensions. They can move around digital spaces and engage one another with voice, text, or by simulating physical interactions. As our online actions and behaviors transition from mobile apps and websites to more immersive XR experiences in the metaverse, avatars will come to serve as our virtual emissaries for everything from shopping, to socializing, to work. Ready Player Me, an Andreessen Horowitz–backed startup out of Estonia, offers a two-part solution for avatar portability: a public creator tool for designing multipurpose avatars, and a developer kit for integrating those avatars into various platforms and interfaces, across which they can migrate freely. Ready Player Me's avatars are built on the Graphics Language Transmission Format standard, or glTF, developed by the Khronos Group, an XR and graphics consortium. The startup Genies provides tools to create NFT-based avatar ecosystems, granting users ownership over their virtual likenesses, and Reddit launched its own NFT avatar marketplace in June 2022. Avatars will increasingly be used not just to represent users in virtual platforms but as the predominant medium for user interaction and communication in the metaverse.

HYPERREALISTIC DIGITAL PERSONAS

Avatars can be created in a variety of forms, but as users spend more time in XR and metaverse platforms virtually carrying out everyday tasks and interactions, there will be rising demand for avatars that can convincingly re-create their true human likeness. Unreal Engine, a leading tool for generating 3D game visuals, launched its MetaHuman Creator in 2021. Users of the app, which promises "high-fidelity digital humans made easy," choose from various templates to create highly customizable, hyperrealistic characters for use in games and virtual experiences, speeding up what had been a weeks-long process to one that takes a matter of minutes. During the launch of Facebook's rebrand as Meta, the company debuted its Codec Avatars, which use 3D-capture technology and AI to efficiently create lifelike avatars for use in the sorts of metaverse environments that will play a central role in the company's future business. CommonGround has raised $25 million for developing a hyperrealistic avatar generator to be used in video applications like teleconferencing without the need for special headsets. Combining smart eyewear technology with hyperrealistic avatars will enable virtual interactions that approach the same level of intimacy as face-to-face engagement, and potentially allow users to replicate themselves in digital form and simultaneously occupy multiple virtual environments. Hyperrealistic avatars will allow users to accurately represent themselves in virtual environments and interfaces, helping to close the perceptual gap between remote and in-person communications. In the further future of the metaverse, hyperrealistic avatars will populate environments rendered with extreme realism, allowing virtual realities to accurately resemble our own.

FRAGMENTATION OF THE VIRTUAL PERSONA

In the absence of standardized universal avatars, users of digital platforms are free to—and in many cases required to—create multiple online versions of themselves, each tailored to the virtual context they inhabit. These digital personas may range from representations of facets of a user's identity to entirely imagined characters. As more digital platforms adapt to the metaverse, and profile photos give way to more complex, dynamic avatars, this fragmentation of online identities will likely become more pronounced, as each of a user's avatars lives a distinct virtual life, developing unique traits and behaviors in its given platform. Without avatar portability and universal identity standards, marketers and advertisers could understand only slivers of users' behaviors, preferences, and intents as they traverse the metaverse, shattering any plans Mark Zuckerberg may have for owning the next-generation digital identifier for monetizing the virtual attention economy.

SPEECH SYNTHESIS

Also known as "synthetic speech" or "text-to-speech technology," speech synthesis mimics real human voices and deploys them to various

DIGITAL IDENTITIES, SYNTHETIC MEDIA, AND GENERATIVE AI

interfaces. With enough data and training, a speech synthesis system can learn the spectral frequency of anyone's voice and produce someone's digital voiceprint. Just three minutes of Andy Warhol's voice recordings offered enough time for developing Resemble AI's training data set for Netflix's "The Andy Warhol Diaries" series voiceover. This technology will be especially useful for movies with wide, international releases; actors' facial expressions and mouths can be reformatted to ensure local languages are correctly synchronized. MIT's Center for Advanced Virtuality and Ukrainian startup Respeecher used speech synthesis to contribute to an "interactive documentary"; they generated Richard Nixon's voice reciting a never-before-heard speech prepared in case the Apollo 11 mission failed. Called "In Event of Moon Disaster," the short film won an Emmy in 2021. Another company, Synthesia, uses this technology to dub people through automated facial reanimation. The tech can also be used for nefarious acts, such as impersonating a trusted figure in an audio conversation to extract sensitive data or make a false request. In 2021, researchers at the University of Chicago's Security, Algorithms, Networking, and Data Lab tested two publicly available, open-source speech synthesis algorithms and were able to dupe voice recognition software from Microsoft, WeChat, and Amazon to access users' devices by artificially re-creating their voices.

MODULATING CUSTOM VOICES

Generative algorithms are creating synthetic voices that sound just like the original, and those voices can be modulated to the exact pitch and tone desired. The AI learns over time to recognize not only intonation but also emotional cadences. Replica Studios, Lovo, Voicemod, Resemble AI, DeepZen, Sonantic, VoiceID, and Descript synthesize voices for a host of purposes. Holly Herndon's digital twin voice allows proxy singers to perform with her voice or harmonize along with her through a filtered microphone in real time. You can fake a conversation between yourself and your favorite celebrity, provided there are enough publicly available audio files of that celebrity to build a data set. Soon, the technology will be able to match and rapidly deploy synthetic voices personalized for every consumer; in one context, a user might hear the comforting voice of a departed loved one or the playful voice of a favorite childhood cartoon.

LIVE PORTRAITS

In the imaginary universe of "Harry Potter," the halls of Hogwarts are hung with framed portraits of past wizards that can move and speak with living observers. Now, with the help of AI, this style of "live portrait" is making its way into the real world. MyHeritage, a genealogy platform, has employed facial recognition and mapping technology from Israeli startup D-ID to offer a feature that synthetically animates faces from old photos. Members of the site can apply the technology to old family photos or those already in the platform's database to create brief, synthetically generated videos of the long-departed appearing to smile, blink, and rotate their heads with eerily lifelike accuracy. D-ID's latest magic trick? Allowing users to animate these live portraits with their own facial expressions, and even create the illusion that the portrait is speaking words of the user's choosing. They've also released a new platform called Creative Reality Studio, which allows users to input scripts or audio clips to animate the image.

A-LIST SYNTHS, VIRTUAL IDOLS, AND INFLUENCERS

With the spread of AI-generated media, a new crop of synthetic celebrities has emerged. Occupying the same cultural roles as their real-world predecessors—singers, models, influencers, brand ambassadors, etc.—these virtual stars afford brands a host of opportunities to make and save money, and will likely play a big part in the emergence of new forms of content and pop culture in the metaverse. At the forefront of the synthetic celebrity scene is Lil Miquela, who inhabits the persona of a perpetually 19-year-old girl and has amassed millions of followers on social platforms including Instagram, Snapchat, and TikTok since she first appeared in 2016. She's been pictured with real-world celebs like Diplo and Millie Bobby Brown, partnered with brands from Calvin Klein to Samsung, released singles on music streaming platforms, and has even been depicted as publicly grappling with the existential quandary of her own existence and awareness of being a synthetic creation. Her appearance and behaviors have been designed, rather than algorithmically generated, by a team of engineers at startup Brud (recently acquired by NFT and blockchain company Dapper

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Labs), which plans to hand some control of Lil Miquela's image and behaviors to her followers and fans—a clear sign of how synthetic media can expand the definition, function, and role of celebrity.

South Korean virtual influencer Rozy is sometimes created with CGI; other times her image is superimposed onto a human model. Sidus Studio X has reached more than 2 billion Korean won (around $1.5 million) in profit in sponsored content partnerships with skin care and fashion brands such as Chanel and Hermès. Prada created the "virtual muse" Candy to launch the fragrance of the same name. Makeup brand NARS created three "Power Players" with Epic Games' Unreal Engine, complete with backstories and careers to match their new line of lipsticks. Additional virtual influencers include Knox Frost, who partnered with the World Health Organization to deliver pandemic safety messages; Lu Do Magalu, who's been around for more than a decade and posts popular unboxing videos and product reviews; and the synthetic girl group NPC, created by musician Grimes, which consists of "infinite members" who can be voted in or out by fans. Since these synthetic stars don't need food or sleep, they can work around the clock and be customized and scaled for countless applications and endless content, making them valuable assets for their creators and various stakeholders, and a major component of the emerging metaverse-oriented media industry. Brand safety may be one appeal of using synthetic stars versus human influencers, but they risk promoting unrealistic—literally—beauty standards. And synthetic stars can get into trouble, too: FN Meka, a rapper created by Factory New, has more than 10 million TikTok followers and was slated to be the first virtual rapper with a record deal, until he was canceled for "digital blackface" and making light of police brutality. To address concerns around ethical standards for synthetic stars, Meta Creative Shop is working with partners to develop a framework that guides their use.

SYNTHETIC MEDIA IN HOLLYWOOD

From Michael Keaton in "Multiplicity" to Tom Hardy in "Legend," Hollywood has already experimented with multiple iterations of the same actor appearing on screen simultaneously, but with synthetic media, the possibilities are endless. An actor could interact with countless versions of herself in a scene, and only have to shoot once—or not at all. An aging or disabled Hollywood star could license out a synthed version of his younger self to be cast in a new film. An up-and-comer could costar with an idol who died decades before they were born. Sound far-fetched? Synthetic media is already starting to make its way onto the big screen. Bruce Willis, who has been diagnosed with aphasia, has been explicit about his plans to continue acting with deepfake technology. The likenesses of Tom Cruise, Leonardo DiCaprio, Elon Musk, and Keanu Reeves have all been convincingly used in ads or TikTok accounts without their permission. Metaphysic orchestrated an entertaining spectacle on "America's Got Talent," convincingly staging a live performance of Howie Mandel, Terry Crews, and Simon Cowell singing opera in real time via body/talent doubles overlayed with synthetic likenesses. Biggie Smalls' virtual likeness performing at a concert available on Meta's metaverse platform raised questions about whether audiences will pay to see the avatar of a long-dead artist perform, and whether such holographic performances are ethical.

SYNTHETIC MEDIA FOR PERSONALIZATION AT SCALE

Founded in 2017, the personalized greeting app Cameo has made a name for itself by connecting public figures of varying levels of fame to average individuals—pay a fee, and the celeb (or B-lister) will record and deliver a personalized message to the recipient, whether it be a birthday greeting, a pep talk, or an apology on behalf of the sender. But as the app grew, so did its selection of celebrities to choose from. In 2021, Cameo added new talent to its ranks: the titular star of hit animated film "The Boss Baby." Partnering with DreamWorks Animation, synthetic video startup Hour One, and synthetic speech startup Lovo, the app was able to offer custom messages delivered by the character, complete with the synthed voice of Alec Baldwin, who voices Boss Baby in the film and its sequel. Though it may be simply a playful innovation for now, this application of synthetic media tech signals a future where popular likenesses could be created to deliver a range of personalized products and services—imagine having a world leader as a virtual personal assistant, a rockstar dedicating a song to each of her millions of fans by name, or even a star-studded film with plot

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and dialogue curated specifically to each viewer's tastes. Synthetic media-driven breakup simulators could allow people to practice difficult conversations. AI-generated porn community Unstable Diffusions' expansive creativity unleashed the full spectrum of the internet's Rule 34 when it comes to NSFW fetish imagination.

SYNTHETIC MEDIA IN THE CLASSROOM AND WORKPLACE

Despite understandable concern about the effects of deepfakes and synthetic media "in the wild," the technology has potentially beneficial applications, particularly in the classroom and workplace. Text-to-video startup Deep Word offers synthetic videos of actors or self-uploaded personas that recite user-generated scripts. Among the top suggested uses of the videos are academic lectures, presentations, and corporate training, and the content can be automatically translated and visually altered to have speakers deliver their message in a range of languages. The ability to customize lessons and workshops at scale for a range of audiences and learning styles can greatly improve the impact and effectiveness of video content at low cost. According to Wired, professional services company EY has experimented with using synthetic media stand-ins of their employees to dynamically deliver client correspondence and pitches that would otherwise be written, terming these digital doubles "artificial reality identities," or ARIs. This technology enables the company to connect with multiple clients in multiple languages at scale; viewers are always informed that they are watching artificially generated content rather than a traditional recording of a human. Legal startup Lexicon is already using GPT-3 to write summaries and suggest edits to lawyers, and "co-pilot for lawyers" Harvey can answer natural language prompts and is backed with funding from the OpenAI Startup Fund.

> It's not a Turing test. It's a character test. Is this character able to surprise me? Can it make me excited? Can it tell me something I didn't know? Can it point me in a direction that leads to the furthering of an experience? In a story rich world, success is anybody you talk to could be interesting enough to hold your attention as long as you like, and you could come back to [them] day after day.

JOHN GAETA, CHIEF CREATIVE OFFICER, INWORLD AI

REGULATING NEW REALITIES

TRENDS

REGULATING NEW REALITIES

THE METAVERSE IS THE WILD WEST

Experiments in the metaverse are not without material brand reputation and consumer risk. In 2022, Interpol announced the launch of a proprietary metaverse platform to train law enforcement worldwide for the evolution of cybercrime in immersive virtual platforms. The types of cybercrime the global agency cites as particular risks in the metaverse are familiar digital concerns—data theft, financial fraud, bullying, sexual harassment—but have new and different implications when translated to immersive environments. New interfaces mean rules and enforcement need to enter a new frontier. Speaking at the World Economic Forum last year, the United Arab Emirates' minister of artificial intelligence urged the UN's International Telecommunication Union to set international metaverse safety standards, noting that certain forms of online harassment become more trauma-inducing when committed in the "realistic world" of the metaverse. Additionally, distributed Web3 technologies expected to play prominent roles in the metaverse have been fraught with opportunistic grift and fraud. Virtual currencies, especially those stored and exchanged on anonymized blockchains, are well suited for money laundering and illicit purchases.

Deepfakes and hyperrealistic avatars can be used to falsely gain the trust of individuals and exploit them, particularly in metaverse workspaces. Bullying and harassment are already the scourges of social networks, having caused devastating real-world consequences for victims; those effects are heightened when insults, threats, and attacks can be delivered by avatars with real voices and animated 3D forms. Real-time audio content moderation remains a significant technical challenge. Meta has already faced multiple claims of sexual harassment in its Horizon Worlds platform. Add haptic tech to the metaverse experience, and virtual contact could be transmitted as physical sensations on a user's body, adding another serious risk factor. Plus, as more users link their metaverse profiles to personal information like biometrics, data breaches could prove far more costly. Historically, tech companies have failed to take responsibility and have been shielded from ramifications of crimes committed on their platforms. Brittan Heller has suggested that we need a 911 for the metaverse, in order to make reporting harassment and abuse "a reflex, not a puzzle." In the meantime, VR headset users are resorting to holding a phone to the eyepiece of their headset to record violations in situ, as screenshots and recordings are not yet easily within their control.

SYNTHETIC MEDIA AND SEXUAL HARASSMENT

Deepfake images of singer Billie Eilish promoting sexually explicit content for purchase were promoted and viewed 11 million times on TikTok's For You page before they were removed for violating community guidelines. The introduction of Stability AI and ease of text-to-image generation has spurred growth of AI-generated porn communities like Unstable Diffusion. While platforms like OnlyFans explicitly ban deepfakes, it's unclear whether generative text-to-porn images will be allowed if they depict the OnlyFans creator. According to cybersecurity company Sensity, approximately 90% to 95% of all deepfake videos fall into a particularly contemptible category: nonconsensual pornography. (The first deepfakes fit this category when they popped up on Reddit in 2017.) Early targets for synthetic sex tapes were celebrities, many of whom have ample public video content to use as source material and plenty of "fans" eager to view the results. But the technology to create a nude version of someone's likeness has become more accessible, with apps like DeepNude popping up before quickly getting banned on most legitimate platforms. The result is that deepfake tech can now be used to create and share synthetic sex tapes of average individuals, a devastating experience for the victims, who are almost exclusively women. These videos constitute a new form of revenge porn, explicit content shared expressly to harm the subject, that is legally restricted in Italy, Germany, Israel, Singapore, Spain, the UK, Canada, and most US states. But these laws have been slow to specifically address the rise of synthetically generated revenge porn, which can be harder to tie directly to the rights of its subjects. One exception is the UK's 2022 amendment to its Online Safety Rights bill that will specifically criminalize the distribution of deepfake pornography without the subject's permission.

DEEPFAKE REGULATION AND SYNTHETIC MEDIA LITERACY

In 2021, a group of US senators proposed the National Deepfake Task Force Act, one of the first federal legislative actions in the US to address synthetic content; it would establish an oversight group within the Department of Homeland Security. Elsewhere, Norway passed a law in 2021 that requires social media influenc-

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ers to disclose when images shared from their accounts have been altered, specifically with regard to the shape and size of bodily features, and Australia's Code of Practice on Disinformation, meant to curtail the spread of manipulated media, has been adopted by major tech companies including Google, Facebook, TikTok, and Twitter. Even China has put forth regulation to protect people from being impersonated by deepfakes without their consent. Platforms like Stable Diffusion embed invisible watermarks in their output, but some critics have argued that synthetic media needs human-legible watermarks to distinguish generative content. The Partnership on AI is also working on developing ethical guidelines and a code of conduct for synthetic media.

COPYRIGHT LAW AND FAIR USE IN SYNTHETIC MEDIA

High-profile generative AI launches from OpenAI's DALL-E and ChatGPT and Stable Diffusion's text-to-image generator have raised thorny questions about fair use. Both inputs and outputs elicit questions: Can copyrighted material be used for training data sets? Are trademarked characters and brands in generative outputs considered derivative works? Many argue that this practice is protected by the US Copyright Office's fair use doctrine, which allows for unlicensed use of copyrighted material in certain circumstances. Factors taken into consideration when determining fair use, however, are the purpose of the use and whether it infringes on the livelihood of the original creator.

So, an algorithm being trained on an artist's work is arguably protected, but that same algorithm being used to generate and profit from an output in the style of that artist—essentially competing in the market with the artist's original work—is likely exempt from fair use and thus vulnerable to a legal challenge. Legal scholars have put forth the concept of "fair learning," acknowledging that the scale of training data sets precludes the plausible ability to blanket license all training material. That said, fair use enforcement is challenging and somewhat subjective, a reality that can be exploited by large platforms. Technologist and former Kickstarter CTO Andy Baio has identified what he calls "AI data laundering," or the practice of Big Tech companies sourcing AI training data sets from or in partnership with academic researchers and nonprofits, obscuring the link between their algorithms' copyrighted training inputs and commercial outputs.

Microsoft, GitHub, and Open AI face a class action lawsuit over GitHub's Copilot reproducing AI-generated code without due credit to training source material. Getty Images has banned AI content for the time being due to legal risk to customers. Shutterstock is setting up a fund to compensate individuals for images used in training sets. DeviantArt is protecting artists with a metatag to bar scraping and reuse into future models of its software. As these tools quickly move from research to commercial applications, the question of creative ownership looms large. Who, if anyone, gets to copyright the generative output of an AI? And how will these platforms navigate monetization strategies if so many authorship rights hang in the balance to be litigated and so many new precedents will be set?

TRUTH DECAY IN AN ERA OF SYNTHETIC MEDIA

With the advent of synthetic media comes the end of the premise that seeing (or hearing) is believing. For the foreseeable future, the general public is susceptible to mistaking synthetic media of a familiar likeness with the real thing. Public exposure to synthetic media is currently limited mostly to device screens, via social media platforms, private messaging apps, video chat portals, and other virtual interfaces. But even now there are risks, as deepfakes—and even "shallowfakes" or "cheapfakes," which are rougher, easily generated versions of their more sophisticated counterparts—can be weaponized to influence human behavior. The result ranges from the spread of misinformation and "fake news," to the false incriminations or humiliation of unwitting individuals, to the manipulation of political elections, especially on platforms where algorithms drive users to share and engage with sensationalized content without necessarily verifying its authenticity. This creates what law professors Danielle Citron and Robert Chesney call the "liar's dividend": public awareness of synthetic media breeds skepticism of all media, which benefits liars who can brush off accusations or disparage opponents with cries of fake news. A Pew Research Center survey across 19 countries found that 70% of people think false information online is a major threat to their country, ranking just behind climate change. Once the metaverse proliferates and users can encounter synthetic media seamlessly integrated into their everyday lives and interactions, these threats become even more pervasive, and any hope of legal protections relies entirely

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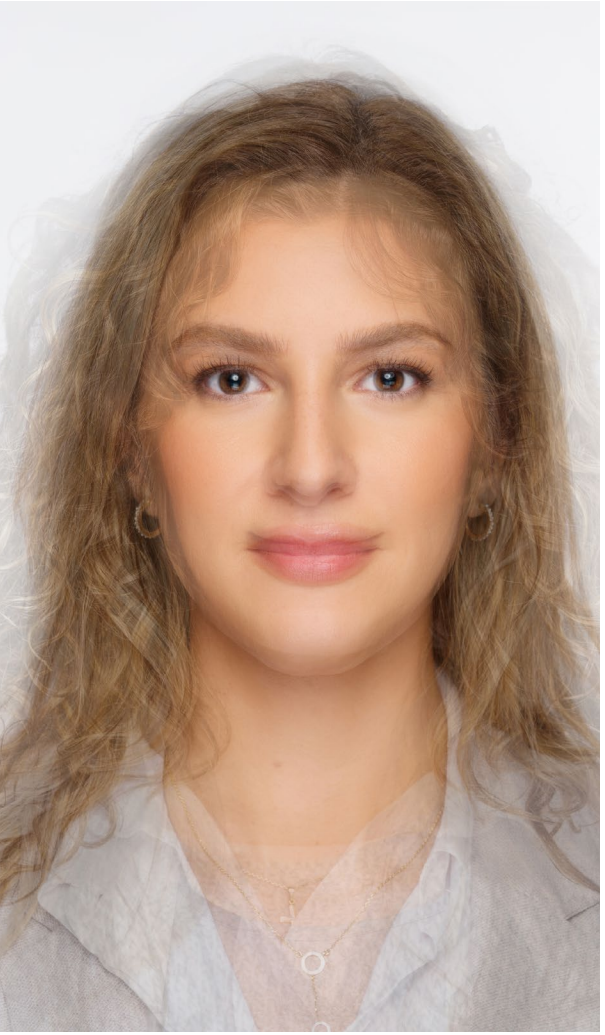

on cybercrime enforcement agencies' ability to detect manipulated media. A Coalition for Content Provenance and Authenticity between Adobe, Intel, Microsoft, and the BBC is working on developing technical standards for certifying the source and history of media content.

DEEPFAKE DETECTION

Last year, a viral synthetic video surfaced in which Ukraine President Volodymyr Zelensky appeared to tell his troops to surrender, but clues in the video—his head was oversized and his accent was flawed—got it quickly removed from distribution platforms. Distinguishing sophisticated deepfakes from unaltered media is a critical security measure in protecting companies and the public from being misled by synthetic media, but so far detection efforts have yet to produce a consistent, superior solution. Research scientists Catherine Bernaciak and Dominic Ross at Carnegie Mellon University have described the field of deepfake video detection—DVD—as a "game of cat and mouse," with advancements in deepfake generation techniques periodically outpacing detection technologies. Many tools are being protected for use only by journalists to allow them an extended timeline to reverse engineer deepfakes. FakeCatcher, a real-time DVD tool debuted last year by Intel, has an alleged success rate of 96%. Instead of looking for what's fake about the image, it uses the novel approach of photoplethysmography to measure light absorption in the blood vessels of living tissue. After working with the Air Force to evaluate the authenticity of faces, voices, and aerial imagery, DeepMedia plans to release a publicly available deepfake detection product in the coming year. The company both generates and detects deepfakes, playing both sides of the rapidly evolving market. MIT researchers have developed an "immunization" process called PhotoGuard to prevent AI manipulation of images.

IMMERSIVE RIGHTS AND PRIVACY IN THE METAVERSE

Just as the internet continues to buck traditional jurisdictional boundaries, raising thorny legal questions about platform accountability and data rights, the metaverse and XR technologies will most certainly raise new questions that stretch the limits of legal precedent and analogy. AR's hypothetical killer app of identifying and providing contextual prompts for the person you met once at a cocktail party likely relies on a facial recognition back-end database that is the stuff of dystopian nightmares. Any concerns users have about their personal data in the form of clicks and identifying cookies will be compounded in 3D virtual and AR spaces. Posture, gait, facial expressions, vital signs, and even attention will become new micro-tracked data sources. Privacy advocates already concerned with the exploitative power dynamics wrought by surveillance capitalism are starting to explore what these battles for personal autonomy and privacy mean when the vectors for digital exposure exponentially increase. Some advocates have argued for rights specific to new realities: Unanimous AI CEO Louis Rosenberg proposes a right to experiential authenticity, a right to emotional privacy, and a right to behavioral privacy. Meta Quest Pro alone has a total of five mandatory agreements and one optional agreement just to get set up in Horizon Worlds. Access, portability, deletion, opt-out, and correction rights will all be important extensions of evolving privacy law for the metaverse. Businesses and tech providers will have to navigate new responsibilities for users' data and protections in new digital frontiers in order to gain and keep their trust.

> It's like Neal [Stephenson] is coming down out of the mountains like Gandalf, to restore the metaverse to an open, decentralized, and creative order.

RONY ABOVITZ, FORMER CEO OF MAGIC LEAP, NOW STRATEGIC ADVISER TO LAMINA1

SCENARIOS

WHAT IF IMMERSIVE EXPERIENCES INVOLVED ALL OF YOUR SENSES—INCLUDING SMELL?

Scenario Year: 2033

In 2022, researchers at Virginia Commonwealth University connected an e-nose with a brain implant and created the first neuroprosthetic for smell. Originally developed for patients who had lost their sense of smell due to injury or COVID-19, the implants were remarkably successful because they could replicate the molecular structure of smells and translate them into signals understood by the brain. With a rich database of olfactory signals, noninvasive assistive smell technology became possible and inspired a new type of wearable built for the metaverse. The latest scent-emitting devices—discreet collars and glasses with built-in sensors that capture and re-create scents—now offer full sensory immersion. Businesses, health care providers, artists, and educators were all quick to apply this technology. Complex smellscapes are incorporated into virtual mental health applications to alter mood, mental state, and cognitive performance. Retailers brand their virtual experiences with signature scents. Educators teach experiential lessons with synthetic odors, having students identify the gases atop a virtual active volcano or immerse themselves more deeply in a digitally recreated ancient world, all with their sense of smell. Artists expand their pieces beyond the audiovisual, creating olfactory-enhanced work at scale.

WHAT IF THE METAVERSE ENHANCED OUR REAL-WORLD DINING EXPERIENCES?

Scenario Year: 2038

After familiar analog comforts were digitized beyond recognition, the metaverse now brings us all back to the reality we once shared. A restaurant's front-of-house is now a sparse, empty space with simple chairs and tables. Once diners connect their smart glasses, the space and soundscape both transform to complement their mood as well as the dishes they order. Powered by generative AI systems, virtual servers appear, greet the customer by name, and make recommendations. On any given night, the empty restaurant transforms into an Edo-era tea house in Japan, where the server is dressed in an 18th century yukata. A musician plays her shamisen, the guitar-like instrument that produces a soulful twang. Tonight's sushi is fresh—because it was made using cultured fish in a bioreactor—and was assembled by robot-assisted human chefs nearby. It's easy to forget that just a few feet beyond the wall isn't centuries-old Tokyo but rather the loud, bustling streets of modern downtown Chicago.

HOW TO PREPARE FOR THE FUTURE

HOW TO PREPARE

What should your organization do now to prepare for these trends?

Now is the time for focused experimentation and learning in the short term, and imaginative scenario planning for the long term, as industries reckon with the disruptive potential of novel computing interfaces that will succeed the internet-enabled smartphone.

STRATEGY

New reality technologies are still very nascent, so it's worth thinking in both the near term and longer term when setting goals and priorities. From infrastructure, to hardware, to software—everything about immersive and spatial technologies is in development and up for grabs. Strategic plans should include provisions for interoperability, data portability, and transparency.

INNOVATION

As digital and physical realities become intertwined, innovation teams in many industries have an opportunity to pursue new moonshots. In 5 to 10 years, if consumers are wearing heads-up displays in the form of glasses or contacts, how could a retail, QSR/fast casual dining, or fan experience look radically different? How does this affect the medical patient's experience? How might connected eyewear integrate with a car or truck? In what ways could a digital twin be additive to real estate, insurance, and city planning? Developing sound moonshot ideas and the applications to match will enable companies to positively contribute to new realities and the metaverse even as emerging platforms are being built.

R&D

Come to virtual and augmented layers of the world with a curious explorer's mindset. Experimentation is the name of the game at this stage, so think bold, imagine what's possible, and be ready to learn from early endeavors. Brands should be a part of the emerging ecosystem, at the very least to learn how consumers behave, interact, shop, discover, and create. Beyond gamified experiences, innovation teams should work toward co-creating digital worlds alongside consumers and technology partners to champion inclusivity and sound ethical practices.

GROWTH

After the short-term hiccups of the current economic climate, Future Today Institute anticipates sustained growth for new realities tech and the metaverse ecosystem over the long term. Austerity will only refine efforts in the technologies' development and filter out the hype. Brands may be more risk-averse in their willingness to experiment in uncertain economic conditions, but the foundations for the spatial frontier of the internet will continue apace. Use this time to imagine longer-term scenarios and effects on your industry, and consider disruptive risks and opportunities.

KEY QUESTIONS FOR YOUR TEAM

1	2	3	4	5	6	7	8
Where might the new realities aid or disrupt our industry and/or our business's value chain?	What affective state or emotions are we hoping to evoke for customers in immersive environments?	What is our customers' demonstrated appetite for immersive media experiences?	What happens to our customer relationships if the smartphone interface disappears?	How can brands ensure that new realities and metaverse spaces are inclusive?	How will we incorporate input and iterate with customer feedback?	How do these new realities efforts serve and align with our brand values?	What does success in the metaverse look like for us today?
	Care, ease, delight, empathy, wonder?	What, if any, assumptions are we making about our user base?		What voices are represented at the table? Who are we overlooking or missing?			In 10 years?

KEY QUESTIONS FOR YOUR TEAM

9

What buy-in and support do we have for taking experimental risks with emerging technologies?

What is our risk appetite for investing in pilots and exploring new business?

10

How dependent upon a proprietary platform is this effort, and what are the risks associated with that dependence?

What requirements would we have if we prioritized interoperability and decentralization?

If digital identities aren't interoperable across platforms, what problems might that create for our business?

11

What ecosystem partners, platforms, and communities are we working with to leverage domain expertise?

12

What other intersecting trends and forces could affect our efforts—climate change, quantum computing, chip shortages, geopolitical unrest, novel pandemics?

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SELECTED SOURCES

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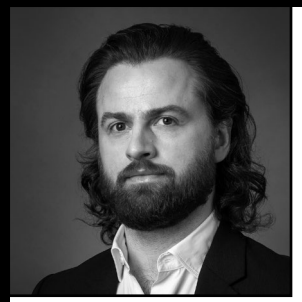

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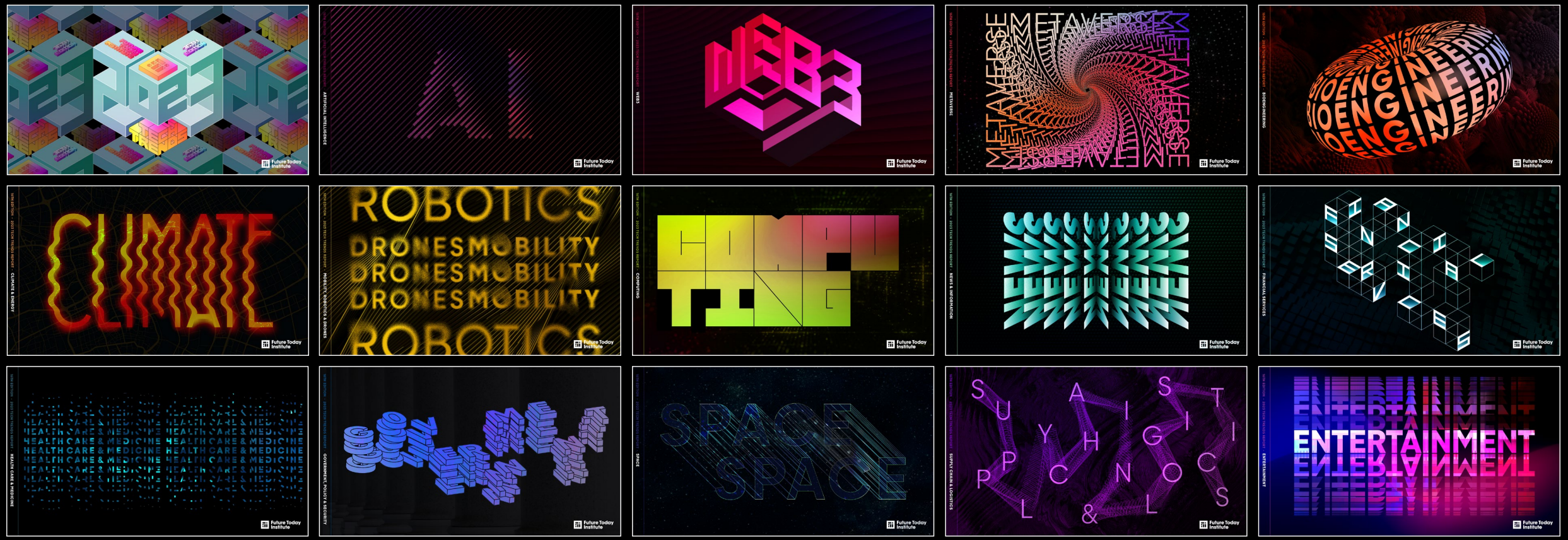

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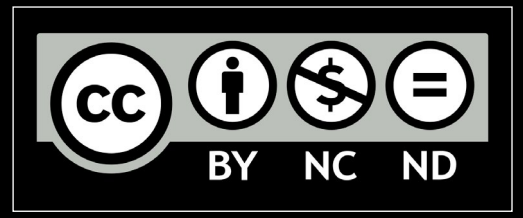

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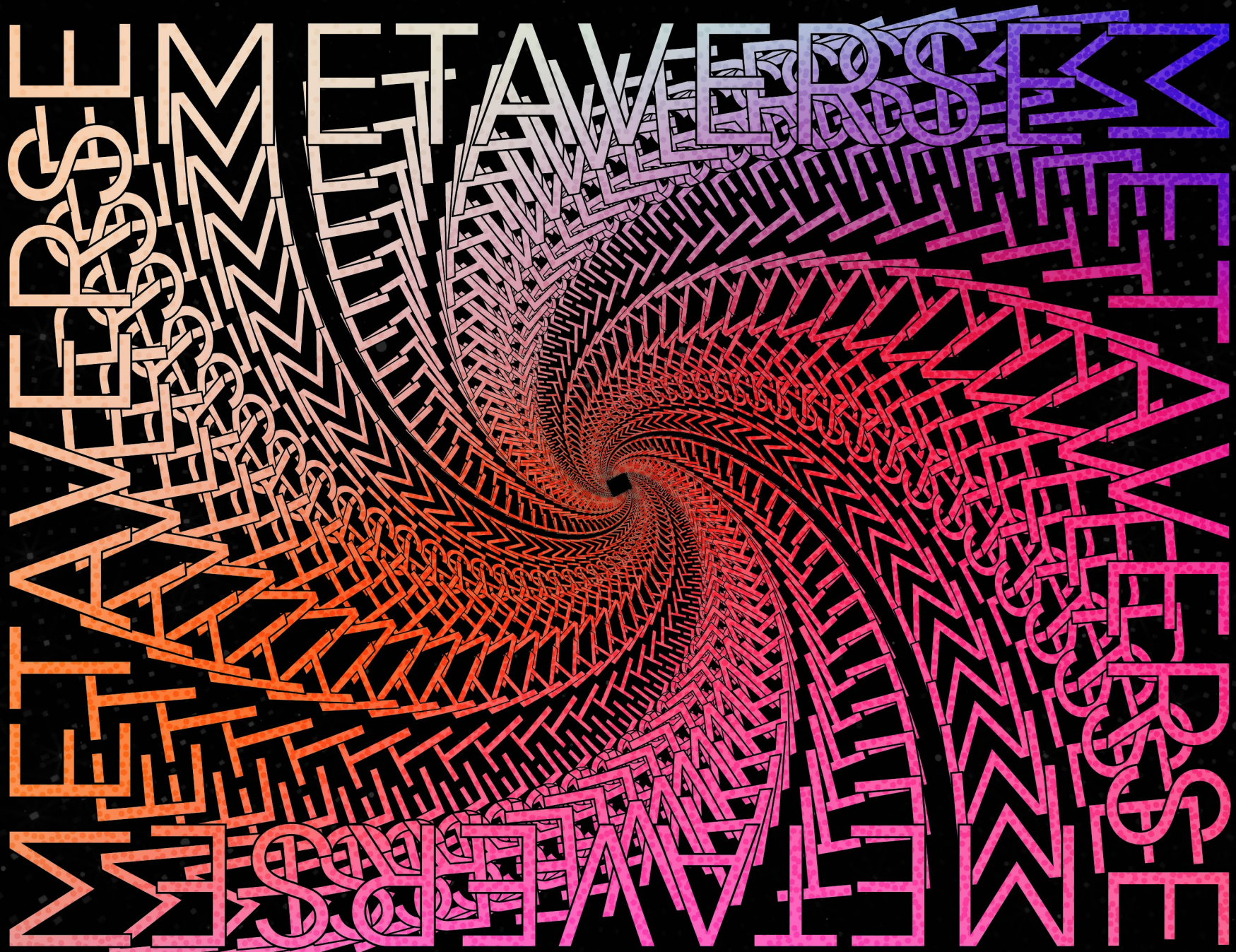

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