40TH Annual Technology Trends List

Daniel Burrus'

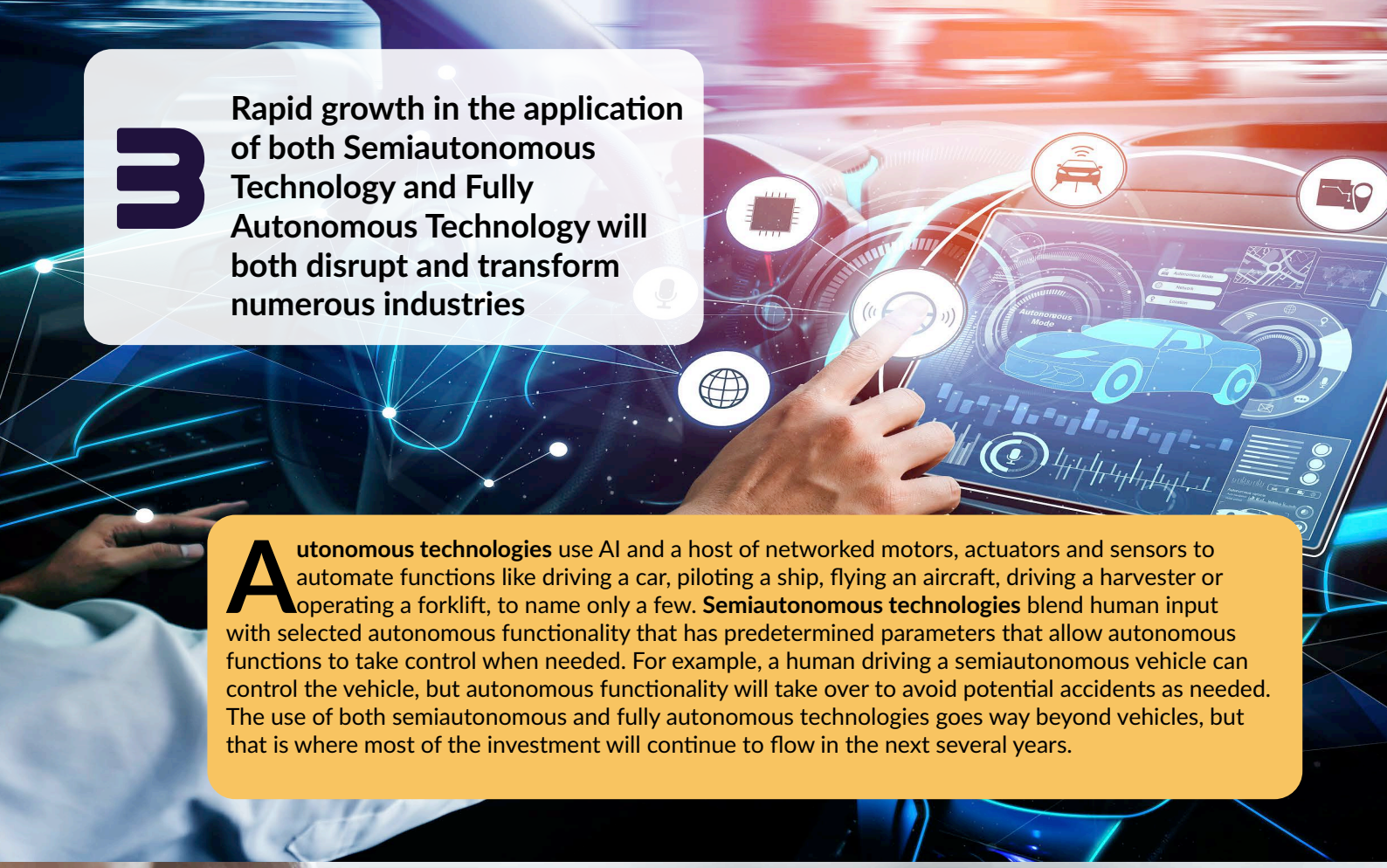
TOP TECHNOLOGY HARD TRENDS SHAPING 2023 ...and Beyond

1 Artificial Intelligence, Machine Learning, Deep Learning and Cognitive Computing will increasingly be integrated into Processes, Products and Services

Artificial intelligence (AI) is a broad category of machine intelligence that includes powerful subcategories, such as **machine learning** (ML), **deep learning** (DL) and **cognitive computing** applications, and it is increasingly being offered as a service, dramatically lowering the cost and increasing the application to every industry. In addition, AI hardware is rapidly shrinking in physical size, soon to the chip level, allowing AI functionality to become increasingly embedded in products, applications, and processes. **AI, ML, robotic process automation, Lo-Code/No-Code** and other rapid application tools enable **hyperautomation systems** to identify and automate redundant business processes. Thanks to the as-a-service model, better sensors, and increased machine intelligence with voice communications, **intelligent networked robotics** will increasingly work with humans in new and productive ways. From **demand forecasting**, **generative AI** and **real-time audits** to **AI-enabled decision-making** and the use of **semiautonomous and fully autonomous vehicles**, humans will increasingly rely on AI.

2 Rapid advances in AI will drive Augmented Thinking and Augmented Movement using Exoskeleton Technologies to new levels of application

Augmented technologies are designed to increase humans' physical and cognitive capabilities. **Augmented Thinking technologies** will increasingly provide real-time actionable insights and knowledge drawn from AI-enabled data analytics of large data sets to enhance human thinking and problem-solving. Humans and AI will increasingly have a symbiotic relationship in which one needs the other for peak performance. **Augmented Movement technologies** enhance physical human functionality. A hearing aid is an example of **sensory augmentation**, an artificial leg is an **appendage augmentation**, and a powered exoskeleton worn by a 95-pound nurse in Japan so that she can lift a 200-pound patient into a bed is a **functional augmentation**. GM workers wear powered **exoskeletons** to lessen arm, hand and joint problems while assembling cars. All of our physical parts and systems, including our genes, can be augmented.



3 Rapid growth in the application of both Semiautonomous Technology and Fully Autonomous Technology will both disrupt and transform numerous industries

Autonomous technologies use AI and a host of networked motors, actuators and sensors to automate functions like driving a car, piloting a ship, flying an aircraft, driving a harvester or operating a forklift, to name only a few. **Semiautonomous technologies** blend human input with selected autonomous functionality that has predetermined parameters that allow autonomous functions to take control when needed. For example, a human driving a semiautonomous vehicle can control the vehicle, but autonomous functionality will take over to avoid potential accidents as needed. The use of both semiautonomous and fully autonomous technologies goes way beyond vehicles, but that is where most of the investment will continue to flow in the next several years.

Advances in AI and wireless broadband are accelerating the application of Voice Commerce, Voice Search, Business Bots and Voice-Enabled Products 4

The use of smart e-assistants and chatbots is rapidly becoming a **mobile electronic concierge** available on any smart device, including phones, wearables, tablets, televisions and cars, to name a few. Standalone audio assistants, including Amazon, Google, Apple and others, will continue to evolve rapidly into **Business Bots** for business and governmental applications thanks to **OpenAI** enabled **ChatGPT**. Retailers will increasingly have a Siri-like **Virtual Sales Assistant**, and we will be increasingly using an **e-Personal Health Assistant** that taps into the real-time health data from a smart wearable such as a smart watch to predict potential problems and offer suggestions. From the **Virtual Help Desk** to sales, marketing and accounting, to services such as investment advice, adding AI enables voice instructions and advice to any product or service will exponentially accelerate.

5 The increasing Datafication of everything creating even bigger Big Data will increasingly drive the use of AI-Enabled High-Speed Data Analytics

Big data is a term that describes the technologies and techniques used to capture and utilize exponentially increasing streams of data. **Edge computing**, **IoT** adding **networked intelligence** to an increasing number of "things" will exponentially increase the amount of data created. The goal is to bring enterprise-wide visibility and insights to users that enable making rapid, critical decisions at the speed of need. Using **advanced cloud services**, **AI-enabled high-speed data analytics** will increasingly be employed as a must-have complement to existing information management systems and programs to identify actionable insights from a mass of big data. **Real-time data audit services** that separate good data from bad data and irrelevant data will also become a rapidly growing service.

Rapid adoption of Advanced Distributed Cloud Computing Platforms and Services will provide the backbone for digital transformations 6

Businesses of all sizes will increasingly embrace new variations in **public, private, hybrid, industrial and personal mobile clouds**. In addition, **distributing cloud services** to different locations with centralized cloud governance will provide many new applications. The shift in how organizations obtain and maintain software, hardware and computing capacity to cut costs in IT has been dramatically accelerated and will continue to transform all processes including human resources and sales management. Beyond cost cutting, new cloud computing platforms and services will increasingly be used to create new products, services and markets. **Industry cloud platforms** bundle cloud capabilities serving specific industries. Not all clouds are created equal. Some are optimized for IoT and edge applications while others are designed for different levels of security and speed.

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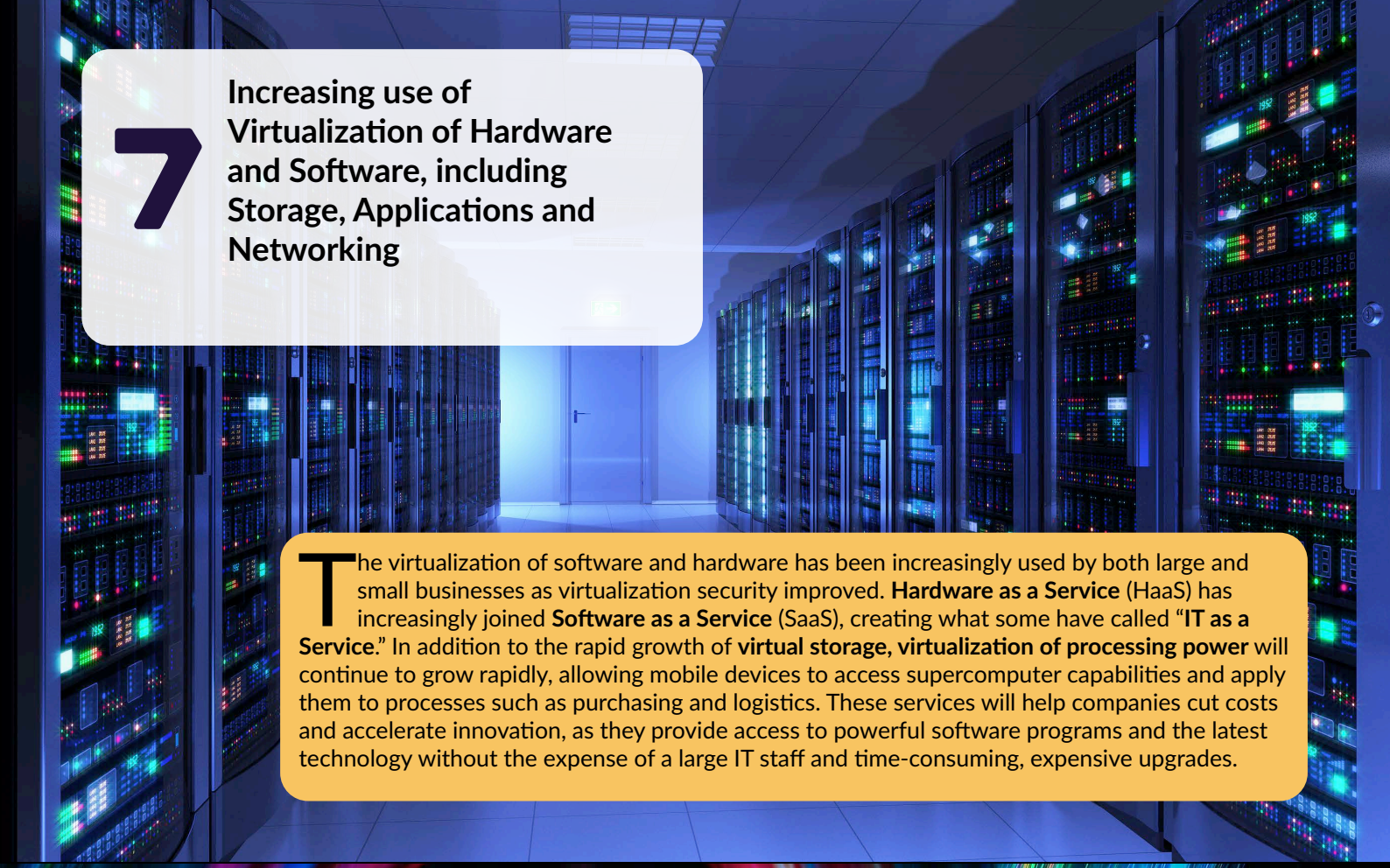


7 Increasing use of Virtualization of Hardware and Software, including Storage, Applications and Networking

The virtualization of software and hardware has been increasingly used by both large and small businesses as virtualization security improved. **Hardware as a Service** (HaaS) has increasingly joined **Software as a Service** (SaaS), creating what some have called "**IT as a Service**." In addition to the rapid growth of **virtual storage, virtualization of processing power** will continue to grow rapidly, allowing mobile devices to access supercomputer capabilities and apply them to processes such as purchasing and logistics. These services will help companies cut costs and accelerate innovation, as they provide access to powerful software programs and the latest technology without the expense of a large IT staff and time-consuming, expensive upgrades.

Virtual Reality (VR), including the Metaverse, Augmented Reality (AR) Applications and Digital Twins, will shift from a rapid evolution to a revolutionary level of applications 8

Augmented reality allows users to point a digital camera at something using a smartphone or AR glasses and overlay just-in-time information about the subject they are focusing on. Soon, Apple and others will be selling conventional-looking AR glasses that allow wearers to overlay data on their fields of vision, providing useful information about what they're looking at. Business applications for AR glasses will grow rapidly. By contrast, **Virtual Reality** uses oversized headsets to shut out the real world and provide an immersive, computer-generated 3D environment with which the wearer can interact. Thanks to new relatively low-cost hardware, new commercial applications for specific industries are rapidly growing. AR and VR have already shifted from a single user to a multiuser social experience now being referred to as the **Metaverse** thanks to Facebook's name change to Meta, and that will drive accelerated growth for both business and gamers in the near future.

9 Increasing use of Social Business Applications, including the VR-enabled Metaverse and AI-enabled Behavior Analytics and Personality Profiles

Social software for business will reach a new level of adoption, with applications to enhance relationships, collaboration, networking, social validation and more. **AI** and **VR** with a social **Metaverse** focus will increasingly play a role to grow engagement. Marketers and researchers will employ **social search** and **social analytics** to measure real-time sentiment of large groups of targeted people. Social media platforms such as Facebook and others are increasingly using AI and **user engagement data** to create **behavior analytics** and **personality profiles** for each user. By identifying an individual user's emotional hot buttons, marketers will increasingly know which buttons to push to get the desired behavior. This has created an unexpected consequence, shifting us from the Information Age to the Disinformation Age. Note that this shift represents a Soft Trend that can be changed.

10 Remote Working using virtual meeting software and services will continue and expand, but many will return to the office to increasingly find a new focus on using face-to-face to elevate communication, collaboration, innovation and sales

Remote working enabled by **virtual meeting software and services** has proven to be a powerful way to leverage human resources and to both retain and attract talent. Many have gone back to the office post-pandemic, but in a new, redefined way. We will increasingly see a strategic combination of remote work and the physical office, not as a place to house employees, but as a place to foster collaboration and innovation. Younger employees will want to live in cities, but older workers who left may not come back since they can now work remotely. Commercial real estate will need to redefine and reinvent itself around new values propositions. Corporate meetings, large multiday events and virtual trade shows will have face-to-face meetings, but most will also have a virtual meeting component in order to expand attendance and impact, as well as offering a new revenue source. We will see a host of new hardware, software and service options for meeting planners, speakers and attendees, including **AR**, **VR** and the **Metaverse**.

Daniel Burrus Instagram Insights

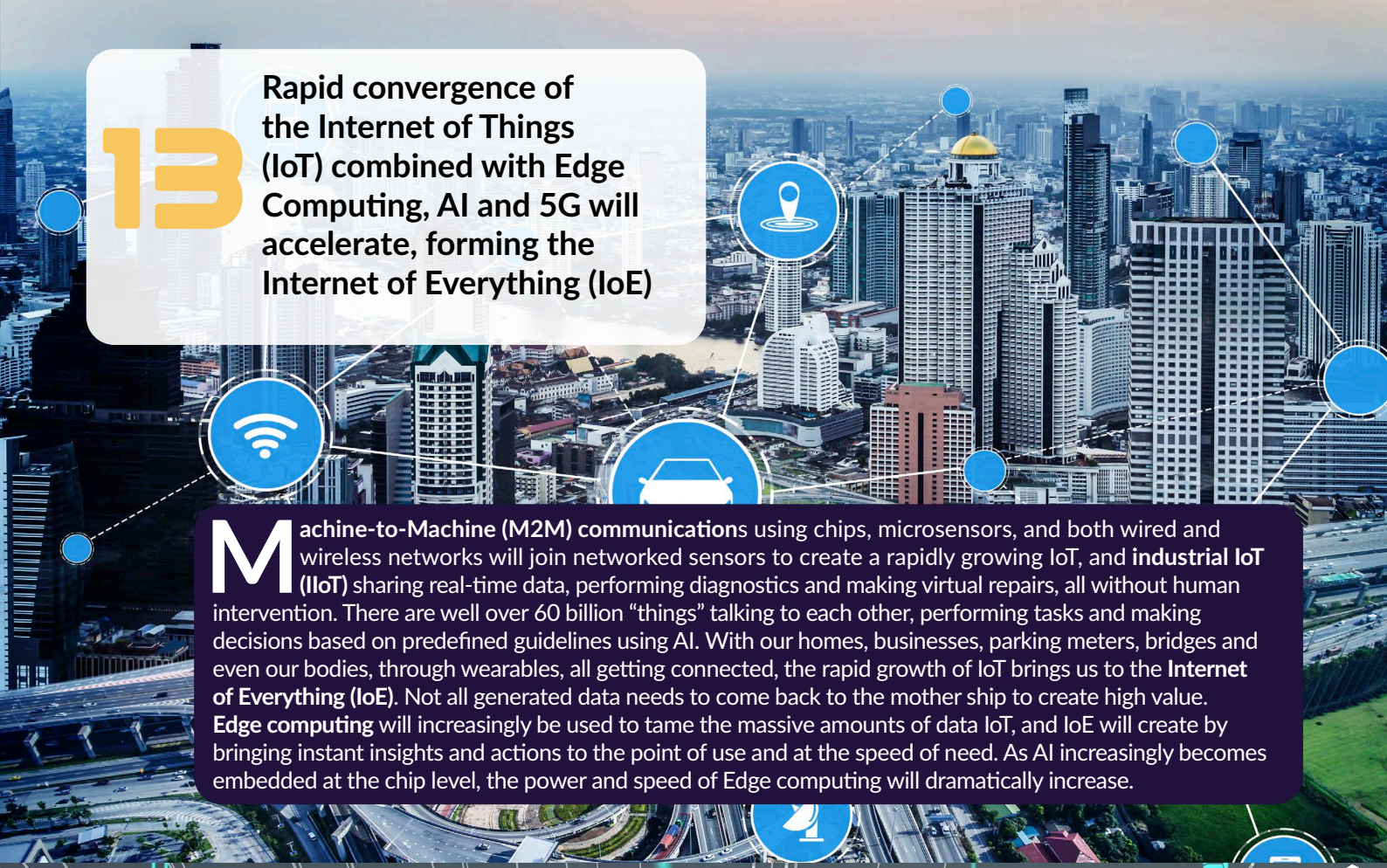
11 Increasing use of Virtualization for Processes and Services enabling Everything as a Service (XaaS)

Advances in cloud platforms, AI, 5G/6G cellular and others listed in this report, will dramatically accelerate the **virtualization of processes and services** by organizations of all sizes needing to update and streamline existing services and to rapidly deploy new and often disruptive services. This will lead to a more **Distributed Enterprise Model** accelerating innovation, digital transformation and driving growth far beyond national borders. Anything can become a virtual service offering and this trend is just now starting to explode. For example, the rapid growth of **Videoconferencing as a Service**, **AI as a Service, Blockchain as a Service, Quantum as a Service, Collaboration as a Service, Security as a Service, Networking as a Service** and **HR as a Service** are a few examples. Traditional products such as cars, trucks, RVs, boats, motorcycles, you name it, will increasingly use a subscription service model.

12 Increasing speed and availability of wireless broadband enabled by Satellite Mega-Constellations and 5G/6G Wireless will dramatically expand personal and business networking on a global level as well as connecting more things

Satellite mega constellations such as OneWeb and Starlink consist of thousands of mass-produced small satellites operating in low Earth orbit combined with a network of ground receivers designed to provide internet service to anywhere on the planet. By providing global broadband access, businesses large and small will have access to a vastly expanded global workforce and customer base. **5G** advantages are already enabling the creation of new multibillion-dollar businesses. There are several variations of 5G, including high speed and low latency, and 5G can be deployed with a public and/or private network. **Wireless value integration** combining a number of wireless systems to elevate value creation throughout an organization, its ecosystem, and customers are already finding new applications to accelerate innovation and growth. 6G cellular is advancing and in the R&D pipeline headed our way.

Daniel Burrus is a highly successful entrepreneur who has founded and managed six successful businesses, is the author of seven books including ***The New York Times*** and ***Wall Street Journal*** best selling book ***Flash Foresight: How to See the Invisible and Do the Impossible***. His latest book, ***The Anticipatory Organization: Turn Disruption and Change Into Opportunity and Advantage*** is an Amazon No. 1 bestseller. *The New York Times* has referred to him as one of the top three business gurus in the highest demand as a speaker.



13 Rapid convergence of the Internet of Things (IoT) combined with Edge Computing, AI and 5G will accelerate, forming the Internet of Everything (IoE)

Machine-to-Machine (M2M) communications using chips, microsensors, and both wired and wireless networks will join networked sensors to create a rapidly growing IoT, and **industrial IoT (IIoT)** sharing real-time data, performing diagnostics and making virtual repairs, all without human intervention. There are well over 60 billion "things" talking to each other, performing tasks and making decisions based on predefined guidelines using AI. With our homes, businesses, parking meters, bridges and even our bodies, through wearables, all getting connected, the rapid growth of IoT brings us to the **Internet of Everything (IoE)**. Not all generated data needs to come back to the mother ship to create high value. **Edge computing** will increasingly be used to tame the massive amounts of data IoT, and IoE will create by bringing instant insights and actions to the point of use and at the speed of need. As AI increasingly becomes embedded at the chip level, the power and speed of Edge computing will dramatically increase.

14 Cybersecurity problems will increase driving the exponential growth of Adaptive and Predictive Cybersecurity Systems coupled with a new level of employee cyber education

Business, government and education at all levels have recently moved cybersecurity from an underfunded back-office activity to a major initiative going forward. With the rapid growth of connected technologies, such as an increasing use of product and service **virtualization, edge computing**, the **Internet of Things** (IoT), **AI, ML**, and **semiautonomous and fully autonomous vehicles**, to name a few, security systems will move beyond reacting faster after a cyberattack occurs, to include adaptive and anticipatory security systems using AI and other advanced tools, such as **behavioral analytics** and **network intelligence**. This will add a level of **Predict and Prevent**, allowing us to stop many, but sadly not all, attacks before they start.

15 User identification and verification technologies such as Multiple Biometrics and Advanced Tokenization will be increasingly applied by organizations and users

Next-gen biometrics and advanced tokenization will increasingly be integrated into computers, smartphones, tablets, wearables and other devices for identity management and security. **Two-factor authorization** and first-gen **biometrics** using finger, facial and voice recognition for identification have helped, and biometrics are now expanding into heartbeat patterns, blood vessel patterns under the skin and much more enabled by new security-featured wearables. Different levels of security will require different combinations of biometrics and tokenization. **Quantum computing** and **quantum communications** represent a major threat and opportunity when it comes to encryption. Quantum computing is already being offered as a service by Amazon and a few others, creating yet another platform for advanced innovation.

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The application of new Blockchains will dramatically accelerate in a wide variety of industries, and at the same time, Cryptocurrency, Digital Currency and NFTs will continue their growth, all accelerating the Web 3 Internet decentralization trend

Introduced as a means of transferring bitcoins, blockchains and related **distributed ledger technologies** (DLT) are increasingly being used in any number of key areas. A system that enables secure, digital direct transfers, blockchains decentralize transactions by eliminating the middleman, thereby allowing for direct connection among all involved parties. Blockchain technology goes far beyond cryptocurrency applications to processes such as the transfer of contracts, insurance policies, real estate titles, bonds, votes and other items of value. **Blockchains** provide increased transparency and, as a result, distributed trust. They will increasingly be applied to low-transparency, high-cost industries, such as the U.S. healthcare market. **Bitcoin** and other **cryptocurrencies** are continued to grow as a hedge as well as an investment even though they remain volatile. **Digital currency** is being tested and, in a few cases, implemented by an ever-increasing number of countries. Blockchain also enables **Non-Fungible Tokens** (NFTs) with applications growing in art and music, as well as being applied to certifications, copyrights and trademarks, to name a few.

Mobile Hardware such as Smarter Smartphones and Tablets connected by 5G will increasingly be used as digital platforms for mobile innovation

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The vast majority of mobile phones sold globally have browsers, as well as having access to **on-demand virtual services**, making a smartphone our primary multimedia computer. As AI is increasingly integrated into the chips in our devices, and 5G networks become the norm, the capabilities of our mobile devices will increase dramatically. This will increasingly create a profound shift in global computing, allowing businesses of all sizes to transform the ways in which they market, sell, communicate, collaborate, educate, train and innovate using mobility. An enterprise mobility strategy that integrates virtualization – **Anything as a Service (XaaS)** and other technologies in this report – will find unlimited ways to accelerate innovation and growth.

18 Mobile Software such as the use of Mobile Apps, Web Apps and Super Apps enabled by 5G capabilities will accelerate mobile application innovation

As we increasingly transform business processes using mobility, the use of **mobile applications** for purchasing, supply chain, logistics, distribution, service, sales and maintenance, to name a few, will continue to grow rapidly. There will be an increasing focus on **multimedia**, **AR** and **VR business applications**, giving companies a competitive advantage and giving users access to the personalized information they need on their mobile devices anytime and anywhere. A new category of **Super Apps** combine features and functions of an app with a large platform to widen its use, tied to an ecosystem allowing third parties to add functionality for their specific users. The low latency and higher speed capabilities of 5G will continue to bring a host of transformative business applications. In the next few years, we will see new billion-dollar businesses enabled by new smart mobile capabilities.

19 Accelerating use of Wearables driven by a growing list of Advanced Sensors will increasingly provide a personalized way to monitor and diagnose physical and mental problems, as well as offer new levels of communication and collaboration capabilities

Wearables will increasingly be used for both personal and business applications as 5G and other technologies in this report converge to create new value streams and accelerated growth. Apple, with its smart watch fitted with an increasing number of health sensors and software, joins Google, Samsung and others in an intensifying battle for market share. An ever-expanding array of new sensors coupled with intelligent software and applications will drive further innovation and sales in other wearable technology. An increasing use of **Smart Patches** that can be attached to the skin for remote disease management, diagnostics and general health information via wireless transfer will expand the definition of wearables.

20 Rapid growth of FinTech, InsurTech and other AI-enabled industry disruptions will accelerate and increasingly disrupt traditional banking, insurance, financial advising, accounting and other industries

AI and automation used by **FinTech** companies to increasingly disrupt traditional banking, and **InsurTech** companies to increasingly disrupt traditional insurance companies, will increasingly be used to disrupt other industry segments such as financial advisory services, accounting and auditing to name a few. A number of the exponentially growing technology Hard Trends in this report, including **AI, Augmented Thinking, AR, Hybrid Cloud** and **Virtualized Services** to name a few, will force many traditional players to learn and adopt new technology-enabled business models by combining an enhanced virtual customer experience with an enhanced local presence providing a redefined in-person and virtual customer experience that leverages high-touch, high-value human relationships that digital only services cannot provide. Traditional players who fail to do so will increasingly struggle, losing both relevance and market share.

21 The adoption of Tele-Education, Remote Instruction, Online Learning and the Gamification of Training and Education will advance rapidly

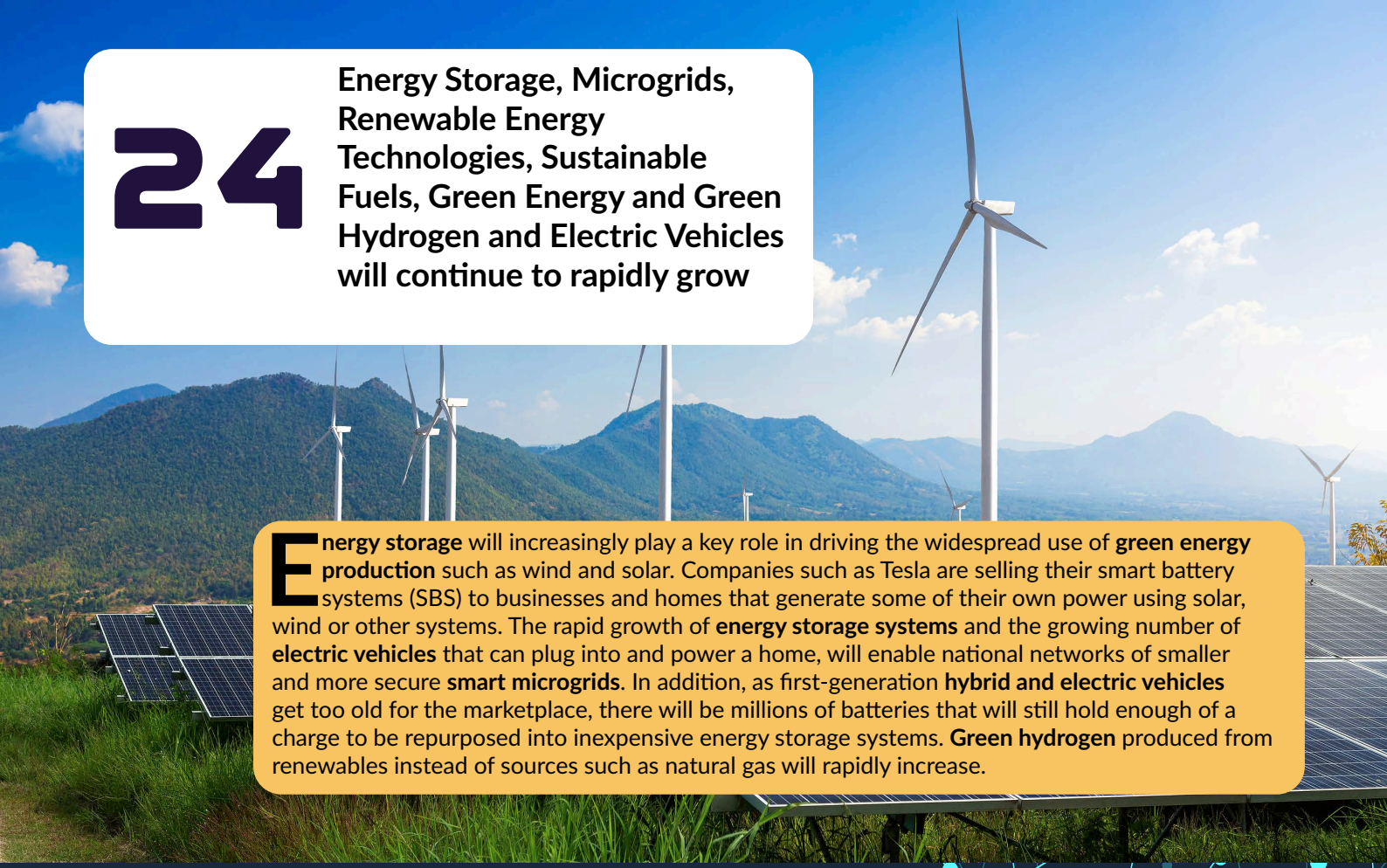
Taking classes online has been dramatically accelerated on a global basis the past few years. **Blended learning**, which uses a combination of online and in-classroom instruction, together with **instructional chatbots** and **AR and VR** tools, will increasingly be used to give students an immersive experience as the need for retraining and reskilling continues to grow. Education and training will increasingly focus on **accelerating learning** by using **advanced simulations** and **skill-based learning systems** that are **self-diagnostic**, **interactive**, **game-like** and **competitive**. By making the experience fun, engaging and personalized, learning will improve, and the use of **gamification** will spread. **Massive open online courses** (MOOC) have already been embraced by highly recognized and traditional educational institutions, putting them in a position to make location and tuition far less of a barrier to receiving the information, training and knowledge people need in order to succeed in a rapidly changing world.

22 Advances in 3D Printing (Additive Manufacturing) is moving from rapid evolution to revolution and it is rapidly being applied to an ever-expanding number of industries

Both **customized and personalized manufacturing** of finished goods using **3D printing** has been growing exponentially and, thanks to global supply chain disruptions, has been accelerated to a new level. 3D printers build things by depositing material, typically plastic or metal, layer by layer, until the product is finished. Originally designed to print prototypes, 3D printers are increasingly being used to print final products, such as jewelry, iPhone cases, shoes, car dashboards, parts for jet engines, buildings, bridges, prosthetic limbs, human jaw bones, blood vessels, organs and much more. This allows companies to manufacture one-of-a-kind or small runs of items quickly, locally and with far fewer costs. **3D printing as a Service** will increasingly be offered by companies such as Amazon and FedEx, which will print (manufacture) and ship any CAD design from anywhere to anywhere. And if they don't do it, others will.

Drones Reach a New Height, Adding AI, 5G and Microsatellite networking 23

The number of applications for drones will continue to expand rapidly. **Drones** have already proven to be of high value from **military applications** including search-and-rescue and medical supply delivery, and the list of applications will grow rapidly as they are applied to an increasing number of industries. Drones can be as large as the largest aircraft and ships, as well as being as small as an insect. Expanding applications include **agriculture** to check crops, fences and cattle; utility companies use them to look for downed power lines; and **real estate** agents use them for aerial photography. The explosion of hobby drones will continue to drive innovation for both personal and industrial applications. The use of military drones in the form of planes, ships, tanks and much more will continue to expand in size and capability. **AI, 5G/6G, microsatellites** and other technologies in this report will be increasingly integrated, expanding capabilities far beyond today's applications.



24 Energy Storage, Microgrids, Renewable Energy Technologies, Sustainable Fuels, Green Energy and Green Hydrogen and Electric Vehicles will continue to rapidly grow

Energy storage will increasingly play a key role in driving the widespread use of **green energy production** such as wind and solar. Companies such as Tesla are selling their smart battery systems (SBS) to businesses and homes that generate some of their own power using solar, wind or other systems. The rapid growth of **energy storage systems** and the growing number of **electric vehicles** that can plug into and power a home, will enable national networks of smaller and more secure **smart microgrids**. In addition, as first-generation **hybrid and electric vehicles** get too old for the marketplace, there will be millions of batteries that will still hold enough of a charge to be repurposed into inexpensive energy storage systems. **Green hydrogen** produced from renewables instead of sources such as natural gas will rapidly increase.

Rapid growth of Genomics, Gene Editing with CRISPR, mRNA and Synthetic Biology 25

Synthetic biology is a rapidly growing field that combines biotechnology, genetic engineering, molecular engineering and computer science, to name a few, that can be used for designing and building engineered biological systems. Applications include processing information, fabricating materials and structures, producing energy, manipulating chemicals and even producing food. **CRISPR** is a revolutionary gene editing technology that can be used to create human cellular models of disease, genetically modified organisms to mimic disease and correct genetic mutations, to name a few. Advances in AI and other technologies on this list have accelerated gene editing, whole genome printing and synthetic biology, creating a new biology-driven revolution with amazing growth potential. **mRNA technology**, used to create successful COVID vaccines in record time, will increasingly be used as a new tool to fight current as well as future diseases.

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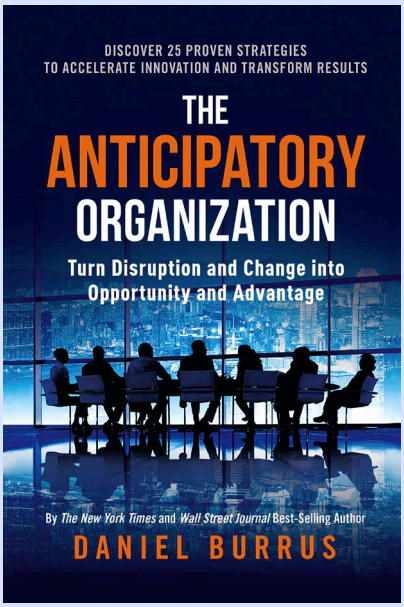

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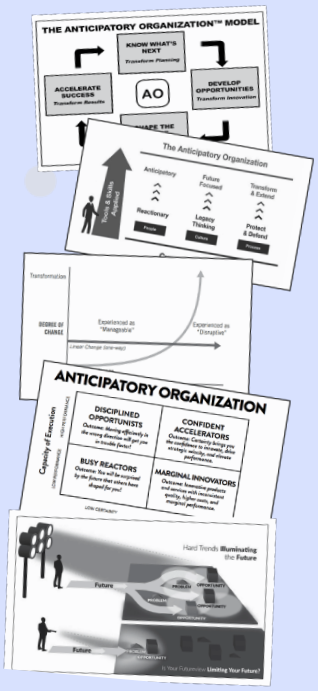

"If you're in business and you're not thinking about disruption, you're not paying attention. And if you haven't read ***The Anticipatory Organization****, you haven't learned how to think about—and get ahead of—the disruption that's headed your way. Read this book!"*

ALAN M. WEBBER
Co-founder, Fast Company Magazine

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Daniel Burrus is considered one of the World's Leading Futurists on Global Trends and Disruptive Innovation. *The New York Times* has referred to him as one of the top three business gurus in the highest demand as a speaker.

He is a strategic advisor to executives from Fortune 500 companies helping them to develop game-changing strategies based on his proven methodologies for capitalizing on technology innovations and their future impact. He is the inventor of the Hard Trend Methodology and The Anticipatory Organization® Model. He is the author of seven books, including *The New York Times* and *The Wall Street Journal* best seller *Flash Foresight*, and his latest Amazon #1 bestseller, *The Anticipatory Organization*.

His first technology trends list was published in 1983 where he listed the 20 Technology Platforms – The Taxonomy of High Technology - that would increasingly drive exponential change and value creation for decades to come.