



XR ASSOCIATION

# IMMERSIVE TECHNOLOGY AND INFRASTRUCTURE: BUILDING AMERICA'S FUTURE



As Congress prepares to develop a modern, sustainable American infrastructure for the next century, key considerations will include strengthening and enhancing American roads, bridges, and public transportation systems; investing in clean energy; transitioning to electric vehicles; climate-smart agriculture; efficient manufacturing; and upgrading buildings across the nation.

In addition, lawmakers will need to think through how best to prepare America's workforce for this renaissance. New jobs will be created, and workers will need to be upskilled and reskilled to meet the moment.

Immersive technology will play a vital role in America's drive to Build Back Better, and it will undergird much of our advanced physical and digital infrastructure. Virtual, augmented, and mixed reality (collectively, immersive technology or "XR") is helping industries across the spectrum become more innovative, more productive, and safer - and helping to train workers in myriad occupations from engineering and construction to manufacturing and farming. What's more, Immersive technologies are already delivering impressive cost savings.

Yet immersive technology is much greater than the sum of its parts. **While XR provides extraordinary game-changing, sector-specific applications across the board, immersive technology will also serve as our next major computing platform, succeeding the laptop and smartphone to enable entirely new ways of working and collaborating.** Over the course of the next decade, the physical and digital worlds will merge at an unprecedented scale. If we are to "future proof" our infrastructure we must embrace immersive technologies today. Immersive technology will pervade American industry as a foundational component of the new economy.

As the World Economic Forum has recognized, we are at the beginning of a Fourth Industrial Revolution – one in which a range of new technologies will fuse the physical and digital worlds, impacting all disciplines, economies, and industries. As Congress sets to work drafting the 2021 infrastructure package, we urge you to incorporate immersive technology. **Not only is XR improving American industry now, it will also be a key enabler of our socio-economic progress well into the future.**



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## Immersive Technology and Hard Infrastructure

### Urban Planning

Immersive technology is revolutionizing the way we approach infrastructure projects. Augmented reality (AR) and virtual reality (VR) allow urban planners, architects, and engineers to enter the space they are working on before any steps are taken in the physical world. XR can assist in identifying and planning around existing networks like electricity, gas, and sewage, and understand the impact on the flow of traffic when new buildings are constructed in commercial areas. What's more, **immersive technologies provide the opportunity to identify and resolve potential design flaws, risks, and issues before and during the construction phase, saving time and money.** These benefits simply cannot be matched by 2-D renderings or 3-D printed models.

**Learn more:**

["How virtual and augmented reality will shape the future of built environments"](#)

["VR/AR Applications: Infrastructure & Urban Design"](#)

["Virtual and Augmented Reality for Planning and Design"](#)

### Public Transportation

From navigating city streets to maintaining railway lines, **XR technology is impacting the way we move through our shared environments.**

In Chicago, developers recently created an AR app that allows users to get detailed information about bus routes by simply pointing their smart phone at the bus stop sign. And scanning a bus stop is just the start. The railway industry is also leveraging XR, using the technology to better predict problems before they occur. Rail maintenance is often unsafe or even impractical, as it depends on factors such as weather and the condition of existing infrastructure. XR allows tracks to be checked remotely and can assist with predictive maintenance. In addition, railway staff are using AR to improve passenger safety and ease the overall rider experience. AR is helping to detect and mitigate overcrowding and rider bottlenecks on subways in real time, as well as assisting with wayfinding, security checks, and scheduling information.

**Learn more:**

["How we enhanced Chicago's public transit with Augmented Reality"](#)

["How is augmented reality changing rail operations"](#)





## Utilities

The number of utility assets that are maintained and monitored is on the rise, and inclusion of renewable energy sources, electric vehicles, and distribution control equipment is increasing as well. Immersive technology is helping companies manage this growth. Major utilities and power companies like Duke Energy, Consolidated Edison, PG&E, National Grid, Electricite de France SA (EDF), PPL Electric Utilities Corporation, General Electric, Siemens, and Fortum are already deploying AR/VR technology. AR and VR improve worker situational awareness and responsiveness, helping the utility industry improve its efficiency. Immersive technology models approximate the extent and location of damage and help maintenance engineers understand what led to an asset failure and how to improve future maintenance procedures, saving time and money and helping to ensure safety in potentially hazardous circumstances. **In short, use of virtual reality and augmented reality in the utility field has the potential to minimize operational costs, improve safety, and broaden the types of services provided.**



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### *Learn more:*

[“AR and VR in the Utility Sector”](#)

[“Virtual Reality to Improve Training of Utility Personnel”](#)

[“Virtual reality paving the way for enhanced safety and efficiency in the power industry”](#)



## Construction

A recent study from ARC Document Solutions found that **construction industry professionals identify virtual reality as the most important emerging technology within the industry** because it reduces errors, increases client satisfaction, and improves safety. Immersive technology allows contractors to spot errors, troubleshoot, and tweak designs before the work crew starts to build. VR technology streamlines the build design process, increases collaboration between contractors and clients, and cuts off “scope creep” before it occurs. Immersive technology is also improving worker proficiency and safety. A study published in the *International Journal of Injury Control and Safety Promotion* found VR/AR training more effective than traditional classroom training, with students demonstrating improved knowledge retention and recall. When incorporated into workplace training programs, **VR training is helping health and safety managers address some of biggest challenges construction workers face: avoiding falls; working in confined spaces and at great heights; operating heavy equipment; and fostering a culture of safety.** Immersive technology allows workers to experience repeatable, lifelike scenarios without facing real-world dangers.

Learn more:

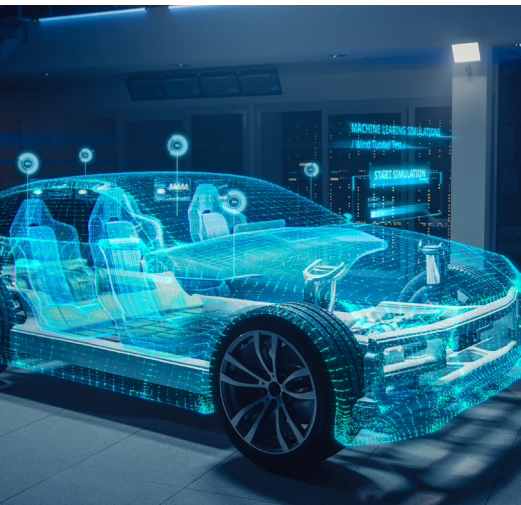
[“National Safety Council Work to Zero: Augmented or Virtual Reality”](#)

[“OSHA Training in Virtual Reality”](#)

[“How Virtual Reality is Changing the Construction Industry”](#)



Virtual reality is being used to test the future of transportation: autonomous vehicles.



## Immersive Technology and the Environment

### Electric and Autonomous Vehicles

As vehicle manufacturers transition from gas-power to electric-power, the challenge of creating an electric architecture from scratch can be significant. Immersive technology provides a solution. **Where traditional processes using hard models can be slow and labor-intensive, VR facilitates collaboration and accelerates prototyping.** VR is enhancing everything from crash testing to aerodynamics. Automakers are finding that designing and testing their products in virtual scenarios allows them to increase the quality of their products, and decrease time-to-market. Immersive technology is also making vehicles safer. Many well-established car brands are beginning to offer a suite of AR features, like heads-up displays that project directions and other information onto the windshield, reducing driver distraction and keeping the drivers' eyes on the road instead of on a screen or smart phone.

In addition, **virtual reality is being used to test the future of transportation: autonomous vehicles.** Using VR, automakers test autonomous vehicle prototypes on virtual test tracks, recreating realistic traffic conditions including weather, oncoming cars, and pedestrians – and benefit from the ability to adjust their designs without creating an entirely new product. This means cars can be tested and validated much quicker, again decreasing time-to-market. Physical prototypes that once took a few weeks or months can now be created in a single day.

**Learn more:**

[Automakers, suppliers and startups see growing market for in-vehicle AR/VR applications”](#)

[“Rivian Off Roads Electric Vehicle Design – Virtual and Augmented Reality”](#)

[“VR and Simulation Tech Make the Auto Industry Safer”](#)



**Agriculture professionals are using immersive technology to improve identification of insects and soil quality.**



## Agriculture

Immersive technology takes smart farming to the next level, allowing farmers to improve existing processes; monitor conditions; increase yields; and limit pest problems. Using augmented reality data, the Plant Vision Initiative at the University of Nebraska, for example, is developing a collaborative AI master ledger to help growers around the world increase yields while limiting farming's environmental impact. Early predictions suggest yields could improve by as much as 500% for certain crops through this data analysis. **Agriculture professionals are also using immersive technology to improve identification of insects and soil quality.** Real-time visualization of crops and their surroundings allow for near-instantaneous identification of insects and associated pest control recommendations and provide assessments of land quality leading to better decisions about land use/crop suitability. Using spatial computing and geolocated data, farmers are improving on-farm productivity.

### **Learn more:**

["Smart Farming is Ready for Augmented and Virtual Reality"](#)

["FarmVR is transforming education, marketing and productivity using virtual reality in agriculture"](#)

["How Virtual and Augmented Reality Help Agriculture"](#)

["New Farming Frontiers—Heat, Pesticides, and Virtual Reality"](#)

## Climate Change Awareness and Resilient Communities

To bring the issue of climate change to life and inspire action, various organizations are turning to immersive media. Using drone photography, a virtual 3D model of a geography is created and the effects of climate change (rising sea level, for example) are then applied, and the images are presented in virtual reality. These simulations can also integrate proposed solutions. In terms of connecting with people on an emotional level, virtual reality - sometimes called "the ultimate empathy machine" - is proving more impactful than informational videos or lectures. As one researcher noted, "even though we know what is likely to happen, numbers on a spreadsheet and 2D maps are no match for VR simulations and the visceral experience of seeing the water level rise, as well as seeing the nature-based solutions we can implement now to make our coasts more resilient."

### **Learn more:**

["How Extended Reality Can Bring Climate Change Front of Mind"](#)

["Virtual Reality Enhances Sea Level Rise Planning and Community Engagement"](#)



## Immersive Technology and Manufacturing

### Manufacturing and Logistics

In the manufacturing sector, XR allows professionals to practice infinite “what-if” scenarios in virtual space - ultimately enhancing safety, delivering cost savings, and improving speed and accuracy. And with respect to product design, VR improves manufacturers’ approach to predictive analytics, helping find design flaws in a matter of minutes rather than months. **As the lead contractor for NASA’s Orion spacecraft, Lockheed Martin is using AR to increase production efficiency and quality:** rather than spending a week on a complex assembly process, technicians wearing AR glasses can finish the same process, with fewer errors, in less than one day. Immersive technology is improving logistics, too. Logistics company DHL successfully carried out a pilot project in which AR was used to implement ‘vision picking’ in warehousing operations. Staff were guided through the warehouse by graphics displayed on AR smart glass to speed up the picking process and reduce errors. The pilot resulted in a 25% increase in efficiency.



**Augmented reality is transforming processes on the biotechnology manufacturing floor.**



#### **Learn more:**

[“How Augmented Reality Became a Serious Tool for Manufacturing”](#)

[“Building the future: How NASA and Lockheed Martin are using HoloLens 2 to go to the moon and beyond”](#)

[“Logistics 4.0 - Augmented Reality Use Cases”](#)

### Biotechnology

**Augmented reality is transforming processes on the biotechnology manufacturing floor.** Through AR, employees are collaborating virtually to maintain supply chains and connect with suppliers and partners - and engineers and scientists are using smart glasses to offer and obtain virtual guidance. Factory floor operators are working with vendors on other continents to detect equipment failures in real-time and engage in interactive problem-solving. Pharma and biotech companies cannot afford mistakes during the production phase. Indeed, even a small error can lead to costly and time-consuming consequences - like having to start from scratch. In a recent example, Emergent BioSolutions erroneously mixed ingredients from two different Covid-19 vaccines leading to the loss of around 15 million vaccine doses. AR allows staff to see the production process virtually, without the need to be there, so that individuals can have eyes and ears on site at a moment’s notice to address an emerging issue. This increased control over the manufacturing process has been described as a game changer by industry insiders.

#### **Learn more:**

[“How Augmented Reality Strengthens Biotech Manufacturing”](#)

## Preparing Tomorrow's Workforce: Immersive Technology and Upskilling/Reskilling



**AR is helping various industries retain crucial skills that could be lost forever as an aging workforce retires.**

As the World Economic Forum noted in its 2020 Future of Jobs report, there is a renewed urgency to take proactive measures to ease the transition of workers into more sustainable job opportunities. Indeed, a “reskilling revolution” will be needed to ensure the talent supply matches the shift in demand. Case in point, **auto mechanics are being trained to service and maintain fully electric vehicles through VR.** Engineering giant Bosch and the Ford Motor Company recently partnered to develop applications where auto technicians use VR to “go inside” an electric vehicle, navigate through various modules as if they were walking through rooms, identify problems, and make repairs.



Similarly, **AR is helping various industries retain crucial skills that could be lost forever as an aging workforce retires.** In the steel and metals industry, for example, the Materials Processing Institute is using AR to capture and transmit valuable knowledge from one generation to the next. AR enables experts to connect with on and off-site employees and customers and collaborate in real-time, allowing remote and local participants to annotate their live-shared view and mark-up the real-world environment. Thus, AR provides a cost effective and easy way to retain skills and experience in a virtual library for generations to come.

### **Learn more:**

[“Ford, Bosch Use Virtual Reality to Train Tech on All-Electric Mustang Mach-E”](#)

[“How Virtual Reality Could Play a Central Role in the Global “Reskilling Revolution”](#)

[“Alabama Industrial Development Training teams with Hyundai for unique job-training initiative using virtual reality simulation”](#)

[“New Augmented Reality deal to help steel industry protect vital skills and move towards net zero”](#)

## Digital Infrastructure, 21<sup>st</sup> Century Computing, and American Competitiveness

COVID-19 has prompted organizations around the world to shift to remote work - and many are now allowing employees to do so permanently. But the Zoom meeting is not the future of virtual collaboration. Instead, tech luminaries are investing billions of dollars in a new virtual ecosystem. This new computing paradigm, known as “the metaverse,” will combine the Internet, the real physical world, and digitally created virtual spaces. In this blended environment, we will socialize, educate, build, conduct business, and provide essential



human services. Just as social media platforms proliferated with the rise of the internet and video-based communication like YouTube became ubiquitous with the adoption of 4G, 5G will enable this next iteration of human-computer interaction. As NVIDIA's CEO, Jensen Huang, told Time magazine in April 2021, the metaverse "is where we will create the future" and transform how the world's biggest industries operate.

China anticipated this paradigm shift years ago and has taken impressive steps towards controlling its future. **Immersive technology - which will be the key enabler of the metaverse - is featured prominently in the CCP's Made in China 2025 strategy**, and the Ministry of Industry and Information Technology, the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Culture, and the Ministry of Commerce have all released detailed strategies concerning immersive technology. In addition, Chinese provincial and municipal local governments are proactively building industrial parks and labs to promote the development of local VR industries.

**If the United States is to position itself as the global leader of the next century, we need to "future proof" our infrastructure.** 5G access will be essential. So too will be our foresight in incorporating immersive technology into our plans for our industrial, economic, and cultural enterprises.

**Learn more:**

["The Metaverse is Coming, NVIDIA CEO Jensen Huang on the Fusion of Virtual and Physical Worlds."](#)

["The Metaverse is Coming and it's a Very Big Deal"](#)

["Virtual/Augmented Reality White Paper," China Academy of Information and Communications Technology](#)



**Immersive Technology is featured prominently in the CCP's Made in China 2025 strategy.**



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## **Immersive Technology and Infrastructure Legislation**

Immersive technology will be a foundation of both the digital and physical infrastructure of the 21<sup>st</sup> century. We are already seeing the positive impact this technology is having with respect to innovation, productivity, cost effectiveness, worker training and upskilling, workplace safety, and environmental interests. Indeed, companies across nearly every sector are adopting AR and VR and incorporating immersive technology into their business models and competitive positioning plans. Yet, XR is far more than the sum of its parts: as virtual and physical worlds continue to merge, immersive technology will become a part of our everyday lives - on both a personal level and

at enterprise scale. If America's plan to Build Back Better is truly geared towards a sustainable and competitive future – a future in which the United States will lead the world economically and culturally – the time is now to incorporate immersive technology into our infrastructure.

**With America's future in mind, we encourage Congress to include immersive technology in its infrastructure legislation in the following ways, among others:**

**AEC Feasibility Study:** Over the past several years, there have been advances in the use of Building Information Modeling (BIM) in the Architecture, Engineering, and Construction (AEC) industry, particularly with the growth of VR/AR. Due in part to a lack of feasibility studies examining the cost-benefit of using VR/AR in the AEC industry, this technology has not been widely utilized. With roughly 98% of construction projects incurring cost overruns, there should be a federally mandated feasibility study of the use of immersive technology to provide cost-savings incentives in federal construction projects.

**Research and Development Grants:** Immersive technology is listed among the "Key Technology Focus Areas" in S. 1260, the U.S. Innovation and Competition Act of 2021, because of its significant impact on economic security, continued innovation, manufacturing, and job creation. Continued support for research and development in the field is critical to maximizing the transformative potential of this technology, as well as its adoption by billions of people worldwide. If the U.S. is to lead the way in immersive technology, Congress should prioritize American efforts in this space as it allocates funding for 21<sup>st</sup> century infrastructure.

**Workforce Training and Retraining Programs:** This paper provides just a few examples of the ways in which immersive technology is being used to train workers in sectors across the board. As discussed, training through AR and VR improves learning and retention; provides a risk-free option for training workers in dangerous fields; and reduces costs and enhances outcomes. Congress should include training in virtual reality and augmented reality for both training new workers and reskilling experts.

**Safety Training Programs:** As recognized by OSHA, companies across the country are discovering the value immersive technologies to build effective teaching tools that allow workers to learn first-hand about the real-world consequences of not following best safety practices. Congress should fund virtual reality safety training programs as part of its overall effort to ensure worker safety as America endeavors to Build Back Better.



**If America's plan to Build Back Better is truly geared towards a sustainable and competitive future—a future in which the United States will lead the world economically and culturally—the time is now to incorporate immersive technology into our infrastructure.**

**Infrastructure Projects:** Immersive technology is improving myriad infrastructure projects from public transportation and building construction to public utilities and city planning. Entities using immersive technologies are enjoying cost savings, eliminating errors, and saving time. Congress should incentivize the use of immersive technology in the many projects that will contribute to America's 21<sup>st</sup> century infrastructure. This investment will result in tremendous efficiencies and improved results.

**Broadband Infrastructure:** 5G will enable the next iteration of human-computer interaction, allowing people to collaborate in virtual environments whether in the same physical space or thousands of miles apart, saving time and money and sharing knowledge more effectively than ever before. Central to the realization immersive technology's full potential is high-performance broadband. 5G will also democratize the technology, ensuring that Americans from the inner cities to rural farmland are able to work together and capitalize on America's vast ingenuity. Congress must expand broadband access to all communities.