



Mixed reality
brings real benefits
to enterprises

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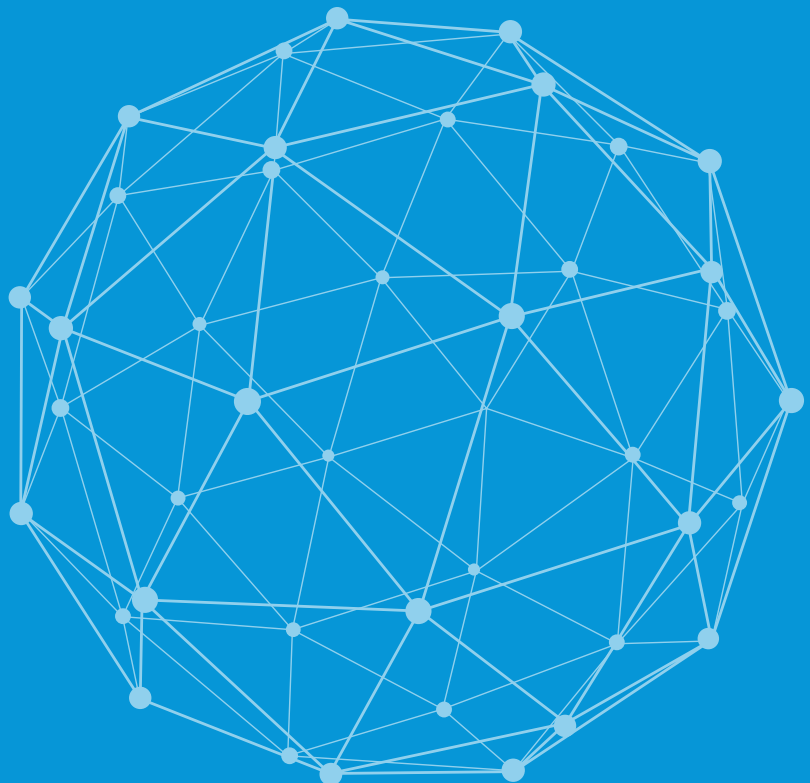


Introduction

Delivered through a head-mounted wearable display, mixed reality technology can provide enterprise employees with the best of both the physical and digital worlds—a real-time view of actual surroundings combined with an overlay of intelligent virtual objects, that allows for new interactions through gesture- and voice-based inputs.

Accenture Technology Labs' ongoing research in mixed reality shows that digital businesses in multiple industries (such as consumer product goods, healthcare, and oil and gas) can gain a clear advantage by using the technology to enable their workforces and expedite current business processes.

What's more, our experience indicates that certain categories of mixed reality applications are good bets for getting started. This point of view explores the technologies behind the mind-expanding digital experience of mixed reality, as well as the etiquette that will shape its use.



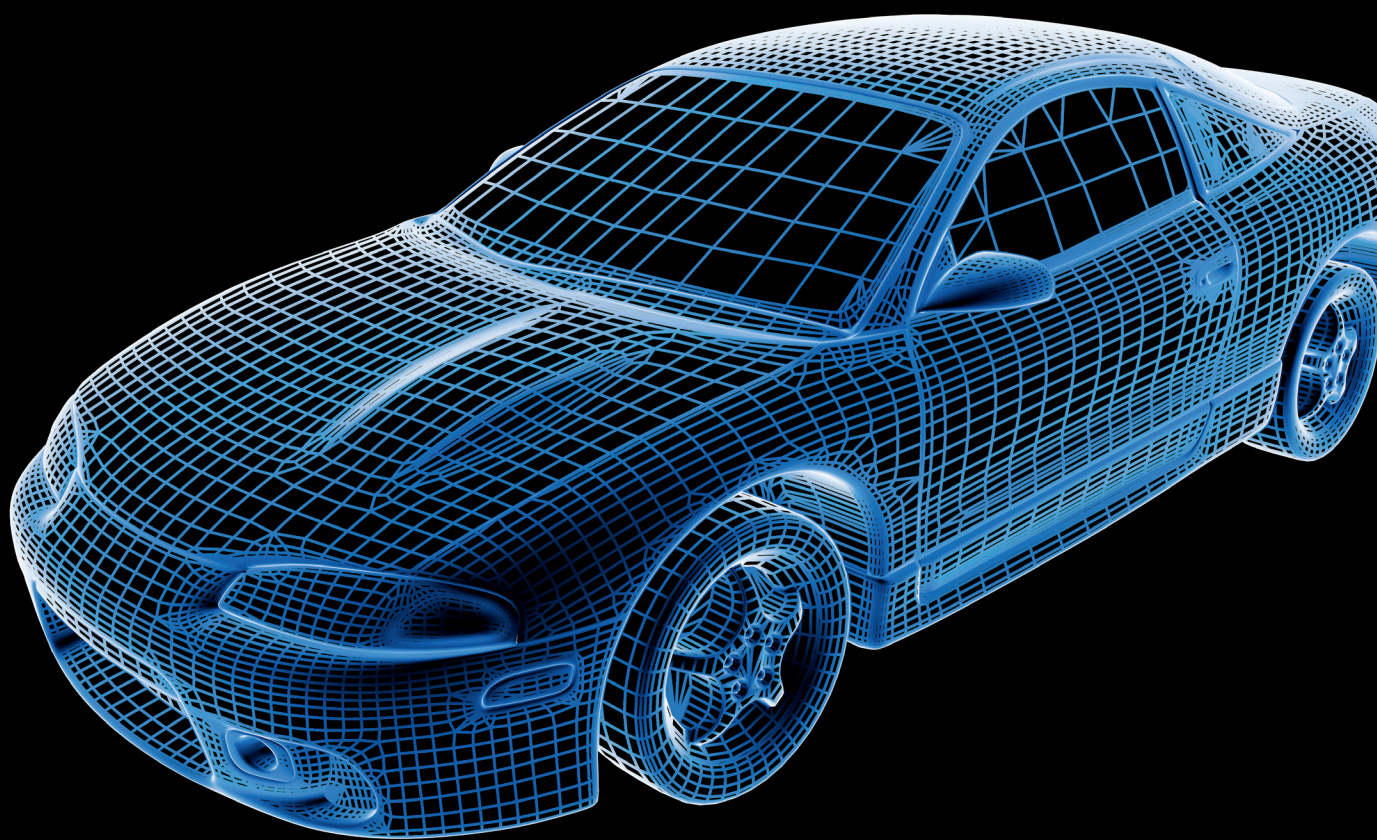
Understanding Mixed Reality

Accenture describes mixed reality as a next-generation digital experience driven by the real-world presence of "intelligent virtual objects," enabling people to interact with these objects within their real world field of view. Think maneuvering a drilling machine from a remote location by manipulating a life-size replica, or placing digital products on a physical shelf and then conducting a design review with a colleague. These are just two of the many potential mixed reality applications poised to deliver tangible benefits to businesses.

Currently, several hardware companies are developing mixed reality devices that offer a deeper sense of the physical world through enhanced sensors, which provide workers with a 360-degree setting for performing tasks. These sensors are driven by three environment-sensing technologies: infrared technology that maps physical surroundings, infrared technology that captures an employee's gesture input, and natural language processing for voice recognition. Complicated machine learning and artificial intelligence algorithms piece together data provided through depth-sense cameras and configure a virtual world around the worker.

Imagine viewing a correctly scaled 3D model of a product in real life, comparing it to the prior version and virtually modifying the product in real time. Or sketching a concept in mid-air for team members in the same room to add their ideas. Or standing virtually on a physical machine floor to help a colleague fix a problem from halfway around the globe. These are some examples of the quantifiable impact of mixed reality.

This combination of technologies enables new experiences that identify where a certain object is located, such as a table, and enable the employee to place virtual content on the physical table without the need of QR codes or other physical markers. In an enterprise setting, for example, a worker wearing a mixed reality headset could walk into a room, use hand gestures and voice commands as input, and enhance the environment without specially preparing or setting up the room itself. This capability expands the potential use cases and relevant scenarios for the technology.



Different flavors of reality experiences

The advancements in mixed reality are based on the predecessor technologies of virtual reality and augmented reality. Here's how they differ:

Virtual reality: Creates experiences that totally block out vision of the real world and replace it with a virtual one using 360-degree video, photospheres or completely computer-rendered environments. Since people cannot see through a virtual reality device, they "move" in a virtual world using a keyboard or controller. For this reason, the experience is typically immobile or requires extensive setup of a physical space.

Virtual reality is best known for use in the video gaming space; however, more advanced devices with sophisticated hardware, such as Oculus Rift, have applications in business. For example, UK retailer Tesco is researching ways to leverage Oculus Rift wearables in a virtual shopping experience. The project is designed to help retailers understand customer behavior, plan shelf space and store layout, and eventually enable shoppers to choose virtual products from virtual shelves to be delivered to their doorstep.¹

On the other end of the hardware spectrum, Google Cardboard enables virtual reality experiences using only a mobile phone. For the National Park Service's centennial anniversary, Accenture helped the parks in their goal to get every 4th grader to visit a park. We built a virtual tour of four park locations that shows interpretation content from park rangers as people explore parts of the park not open to visitors.^{2, 3}

Augmented reality: Provides workers with billboard-like information about a task, either on an alternate screen or through projecting images onto lenses in front of the eyes. Examples of the heads-up display (HUD) experience include Google Glass and Recon Jet. These technologies adopted the term augmented reality although they are more location-based relevant than contextually overlaying data on what the worker sees.

True augmented reality displays are independent devices with full-screen displays in front of the eyes, such as Epson's Moverio and ODG's R-7 glasses. Worn as glasses, these displays project images or content onto the lenses and work in tandem with a camera in the front of the devices to recognize known markers or QR codes, and then to create augmented reality overlays of the physical world in front of the person. This approach drives business applications that allow hands-free information access, with contextually-relevant information about the worker's environment. To learn more, see Accenture's point of view, "Putting Wearable Displays to Work in the Enterprise."⁴

People are also becoming familiar with augmented reality functionality through smartphone apps. Services like Blippar (formerly Layar), Vuforia and Wikitude take advantage of a phone's camera, gyroscope or a physical QR code marker to display virtual content on the screen. The markers can be disguised as digital patterns or the labels on branded merchandise. These experiences are increasingly being used in advertising campaigns, which help consumers develop deeper connections to products through additional features like games and special offers. As an example, Accenture Technology Labs created a "WeShop" demo that personalizes in-store retail advertisements based on a customer's profile.

Mixed reality: For businesses, mixed reality devices can vastly increase people's knowledge of the world around them by overlaying information in the context of the real world. It can also enhance collaboration by enabling remote teams to see exactly what someone is working on in real time so that they can provide better directions. Another key advantage of mixed reality devices is that they provide these capabilities while allowing a worker to perform tasks with their hands free from a required controller, such as operating machinery and using tools. This is particularly useful for manual labor in remote or dangerous locations.

Technologies converge to power mixed reality

Although the software and hardware components existed previously for virtual reality and augmented reality, technology only recently become sophisticated enough to create the full experience of mixed reality. The two essential software pieces include:

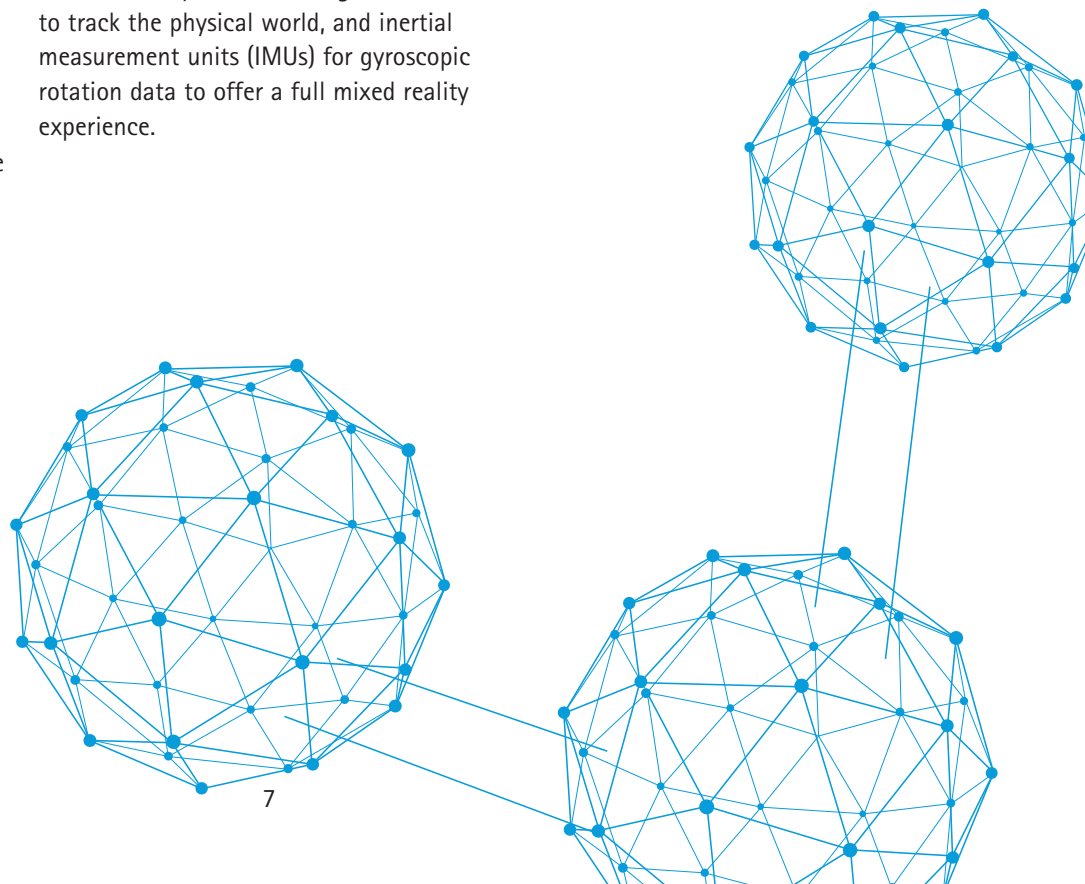
- **Image recognition**—The ability of a computer system to quickly and precisely analyze an image and identify features within it. The simplest augmented reality apps can use QR codes to recognize specific objects or surfaces for interaction. Mixed reality, however, needs to use more advanced image recognition to conduct object recognition to identify walls, floors, tables and other objects dynamically for a worker to interact with.
- **Simultaneous location and mapping (SLAM)**—A suite of technologies geared towards locating a person and mapping the environment concurrently. SLAM is key to mixed reality applications. In order to function in new, unknown or changing environments, the technology needs to both continuously create a map of those environments, and then locate and track a person's movement within them. SLAM algorithms for mixed reality use image recognition and depth sensor data to calculate where the user is in the physical world.

The computing power of the hardware—central processing units (CPUs) and graphics processing units (GPUs)—has increased to the point of calculating SLAM algorithms in real time, while the physical size of the CPUs and GPUs has been miniaturized to fit on lightweight, comfortable head-mounted displays.

In fact, real-time processing is crucial for the mixed reality experience in terms of latency. If there is a delay in understanding how the environment or perspective has changed, any digital content being rendered on top of the real world will lag behind the physical, which will break the illusion being created. Without using SLAM to gather a real-time understanding of the real-world environment surrounding the worker, it is not possible to have the digital world blur with the physical.

Real-time augmented reality, such as Epson's Moverio headsets, were the first to market, leading to technologies like Microsoft HoloLens and Meta's Meta Pro. These two products combine the visual overlay element that places screens in front of the eyes, time-of-flight sensors to track the physical world, and inertial measurement units (IMUs) for gyroscopic rotation data to offer a full mixed reality experience.

If augmented reality is a reference manual for workers, mixed reality is a digital tool that can recognize an environment and seamlessly recommend experts, enterprise systems and reference material necessary to complete a task.





1980s

Companies experiment with building wearable hardware that can fit in custom backpacks.



1990s

Forward-thinking businesses use early virtual technologies like cave automatic virtual environment, better known by the acronym CAVE, for immersive virtual reality product engineering,⁵ capital project planning and other business applications.



2012

Oculus Rift receives crowdfunding to build a consumer-oriented virtual reality headset that brings head-mounted wearables to the mainstream audience.



2013

Accenture builds prototypes on Google Glass for oil and gas, healthcare and retail industries.^{6,7}



2015

Accenture works with the National Park Service and the National Park Foundation to launch a virtual reality application, NPS Virtual Tours, that uses Google Cardboard for iOS and Android.⁸



2015

Accenture's digital design groups, Fjord and Chaotic Moon, work on advanced virtual reality applications for education, health and tourism.⁹



2016

Chaotic Moon showcases a Samsung Gear VR app at the AT&T Developer Summit that helps people overcome phobias.



2016

Microsoft and Meta release commercial editions of their mixed reality headsets.



Robotic Station # 3
Next Maintenance:
02-14-2017

Distribution System:
Cincinnati 14
Memphis 24
Charlotte 6
Gainsville 12

No. 3 ASSEMBLER
Parts List:
00426 Folder blade
» PHOTO

Bill Wilson
PTO SCHEDULE
Tuesday 4-9-16
SHIFT SCHEDULE
6-3: 4-7-16/5-23-16

RIVERSIDE PLANT:
April performance stats
PTM: 3267
Goal: 3750
ID: 12400



Pkg/min: 65
NAC: 2
Monthly QPC: 10

Application of mixed reality

Based on the unique aspects and experiences delivered by mixed reality, digital businesses are beginning to explore a variety of use cases. Accenture Technology Labs has identified three categories to explore further, each of which has differing impacts on business processes and how employees perform their jobs. The categories are:

People first applications

Many applications were originally created to display data or information from a centralized location. When enterprises enabled access to these apps via tablets, smartphones or smartwatches, employees enjoyed faster access to the same information. This greatly changed the way people work, especially in terms of mobility and hands-free work. Mixed reality is the next step. However, instead of arbitrarily providing data to the worker, the software and hardware will work together to display extremely context-relevant information in a physical space.

Imagine a manager working in a production facility. Instead of looking at a dashboard of metrics on a screen in her office, the manager could walk through the plant and see contextually relevant information overlaid above each piece of machinery.

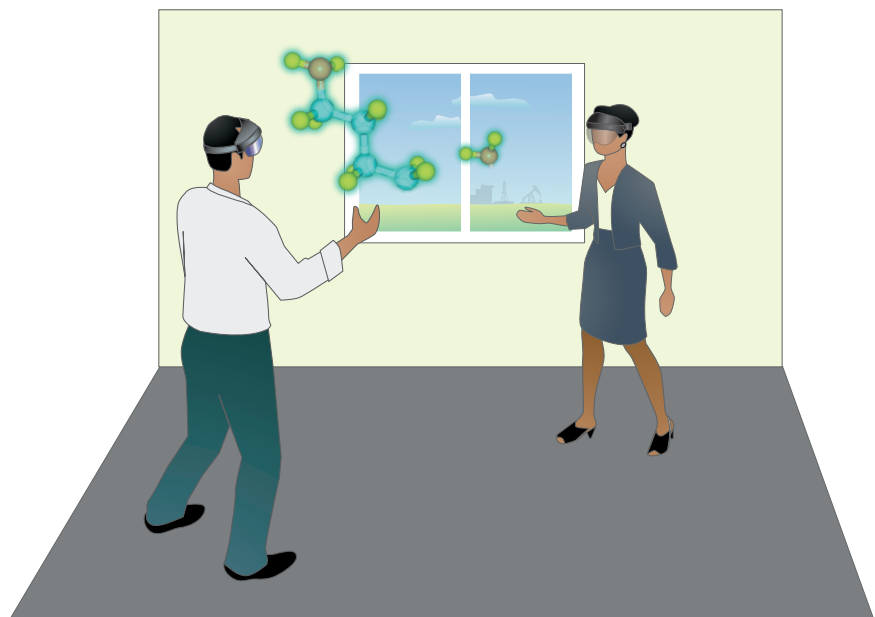
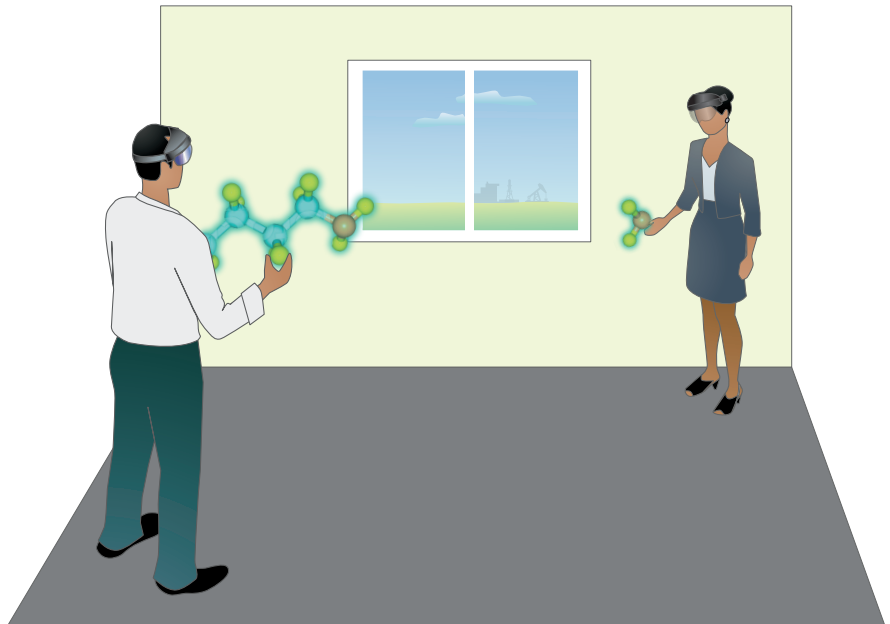
Examples include the output rate of the product being manufactured, or any required maintenance or inspection data for the equipment.

Accenture has conducted a study that compares different types of media and their impact on people's perception of the visualization displayed. The data confirms that immersing a worker deeper into the content enables them to create a stronger connection with it. Displaying information in a contextually relevant manner (as opposed to flat on a dashboard screen) will accelerate the pace of decisions in a people first way.

Sharing real-world virtual workspace

Bringing together multiple mixed reality devices in a shared space will open up new collaboration options. With mixed reality, team members can be networked into a shared virtual world overlaying the physical. In this connected environment, they can collaboratively work together on the virtual objects and have the items interact with each other and the real world. This new collaborative capability is made possible by the real-time mapping and image recognition capabilities.

This mixed reality experience could be especially beneficial for sales representatives when pitching a new offering. A pharmaceutical sales rep, for instance, could bring two mixed reality devices to an appointment. The doctor and the sales rep could wear the devices and see a scaled-up model of the new medicine projected into the office. Together, they could visualize the chemical breakdown of the drug and see how it moves through the body to fight a disease. By providing this shared experience, the sales rep can build a deeper connection with the doctor while offering a more thorough explanation of the new product.

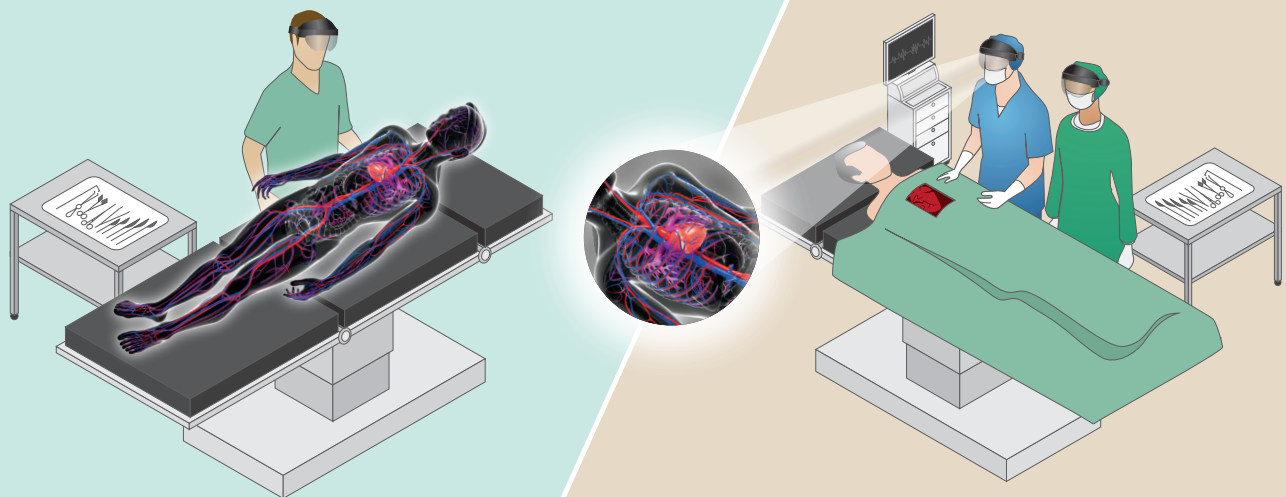


Remote experts (over-the-shoulder coaching)

Many enterprises struggle to address all of the support requests from workers that require expert advice. Flying specialists to various locations to fix things is both costly and time consuming. Troubleshooting an issue over the phone, even with a photo of the broken device, can be inadequate. Even video conferencing has its limitations, since the workers must glance at a tablet screen or hold a smartphone in their hands while trying to conduct the repair.

Mixed reality offers a hands-free method to access an expert quickly and inexpensively. For example, an oil and gas technician working on a drilling rig in the middle of the ocean can send a video feed of what he sees, and the expert can annotate the 3D world displayed on the mixed reality headset to direct the task. This approach would not only reduce error rates, but also make the experts more accessible for different types of support multiple times per day. In another example, Accenture is working with a leading healthcare client to remotely connect doctors with emergency responders in the field to quickly offer care guidance and decisions.

Remote expert coaching could also be pre-recorded and stored in a training library for employees. For instance, an auto manufacturer could offer mixed reality training packages to help mechanics maintain vehicles. The device could display instructions over the engine highlighting components and annotate the maintenance tasks directly over the physical part.



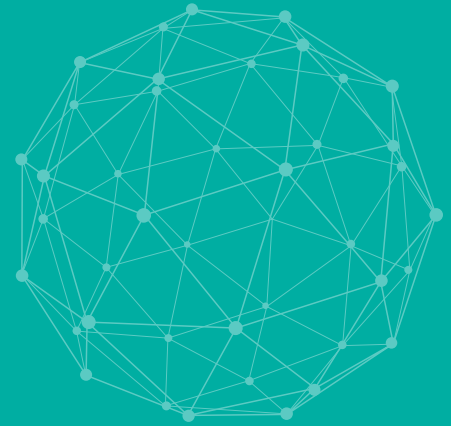
How will people's interactions change because of mixed reality?

Mixed reality has the potential to change how people work, communicate and relate to the world. Accenture Technology Labs expects to see an expansion of enterprise applications as the technology matures and devices get smaller and more affordable.

Topics such as etiquette and socially acceptable uses will need to be considered. How does a worker with a mixed reality device interact with others around him? How do groups of people work together in mixed reality? How will social norms change to accommodate mixed reality holograms that can only be seen by some people?

Likewise, how will someone's daily routine change by this technology? Will mixed reality become ubiquitous like mobile phones, replace typical workstations or remain something worn only for certain tasks throughout the day? Will we have massive, shared mixed reality experiences and how will that change people's day-to-day interactions?

Since mixed reality experiences are set in the physical world, people will react to them more emotionally than purely digital experiences. As the technology matures, it will be critical to be aware of these issues and design for them.



Conclusion

Mixed reality represents a new and digitally expansive experience. Leading businesses have already begun experimenting and iterating new ways to embed this advanced technology into business processes and employee workflows.

It will be important to incorporate lessons learned from mobility, virtual reality and augmented reality into the overall experience of blending the visualization of complex data with the physical world. Questions that will be addressed in upcoming months as mixed reality devices come to market include:

1. Which platform will capture the most traction? Determining which features are most important for workers in the tasks they need to complete will be critical. This could lead the industry in different directions as the hardware advances.
2. What is the best practice for wrapping complex data types into physical environments? Do people prefer a distinguishing difference for virtual objects or do they want them to blend in? As mixed reality experiences are built, a person's perception and acceptance of digital items might evolve. Developers will need to be ready to adapt.
3. Which aspects of business will be cannibalized by mixed reality? How should businesses approach this? Mixed reality accelerates communication at disruptive speeds, and businesses will be faced with choosing between positioning towards new growth by rapidly adopting mixed reality, or risk watching their competitors adopt it first.

Because it is still early in the maturity of mixed reality devices, it is critical for enterprises to consider their primary advantages and experiment with how they can provide the most impact. Use cases, ways of interacting, applications and even the hardware of mixed reality itself will continue to evolve, similar to the early evolution of smartphones. This provides an incredible opportunity for those willing to invest in this technology now. The promised capabilities of mixed reality technology are strong and finding those experiences will give leading enterprises a distinct advantage.

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About Accenture Technology Labs

Accenture Labs, the dedicated technology research and development (R&D) organization within Accenture, has been turning technology innovation into business results for more than 20 years. Our R&D team explores new and emerging technologies to create a vision of how technology will shape the future and invent the next wave of cutting-edge business solutions. The Labs collaborates extensively with Accenture's network of nearly 400 innovation centers, studios and centers of excellence located in 92 cities and 35 countries globally to deliver cutting-edge research, insights and solutions to clients where they operate and live.

The Labs are located in Beijing, China; Sophia Antipolis, France; Bangalore, India; Dublin, Ireland; Silicon Valley and Arlington, Virginia in the United States.

For more information, please visit www.accenture.com/labs

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