Virtual & Augmented Reality for Dummies

Learn about virtual, augmented, and mixed reality
How to apply these technologies in your business
The history and future of VR and AR

Paul Mealy
Virtual & Augmented Reality

by Paul Mealy

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Introduction

Around 25 years ago, I visited the Forest Fair Mall in Cincinnati, a large, sprawling mall that has since closed down. One of the greatest features of this particular mall (to an 11-year-old kid) was the basement arcade. Running the full length of the mall, it had everything you could want: a Ferris wheel, bumper cars, mini golf, laser tag.

But the pièce de résistance was a pair of Virtuality pods, a virtual reality (VR) experience created by the Virtuality Group. The Virtuality 1000 featured a stereoscopic head-mounted display helmet (HMD), an exoskeleton touch glove and gun, and a waist-high ring used to track a player’s movement within the enclosure. This specific VR experience was a local user multiplayer experience: Take on all comers in a high-energy laser battle!

My father patiently waited in line with me and handed over the $10 for me to play. By the time I reached the front of the line, I was bouncing off the walls with excitement. As the helmet was lowered onto my head, I closed my eyes, mentally preparing myself for the wonders of the virtual world I would be entering. Where would I be transported to? A lush, Amazonian jungle? A gleaming futuristic metropolis? Surely my imagination could not prepare me for the wonders I was about to behold.

Thus prepared, opening my eyes, I found . . . a mostly empty, boxy world populated by pixelated characters. Confused and disoriented, I glanced around the crudely rendered environment, the tracking barely keeping up with my movements. I was being assailed with lasers (really, blocky lines), but the resolution of the headset was so limited, I couldn’t even determine where I was being shot from. I was quickly eliminated from the game, and the headset came off. My less than two-minute experience in VR had left me (and my father’s wallet) deflated.

Fast forward to 2013, and I found myself working in the emerging technology field. The industry was abuzz with the “next big thing”: the Oculus Rift Development Kit (DK1), a VR headset originally launched via Kickstarter. Still sporting the scars of my previous VR experience but determined to see what the buzz was about, I sorted through the mess of cables in the development kit, hooked it up to my computer, and put the headset on with trepidation, preparing myself to be let down once again by the promise of VR versus the reality of VR.

Instead, all the things I hoped to experience in that Forest Fair mall years ago were delivered. The Rift tracked my head movements accurately! The visuals were
convincing! Instead of floating in a vaguely 3D-ish landscape populated by blocks, I could wander about a Tuscan villa, watch butterflies flutter by, stand by a roaring fire, gaze out the windows . . . 3D audio tying it all together. It all felt so real. With little to actually accomplish in the demo scene (no monsters to fight or riddles to solve), I (and everyone I showed the scene to) could spend hours just wandering about the villa, for the first time truly immersed within VR.

What was little more than a simple demo scene for a Kickstarter startup became the headset that launched a thousand companies. In one fell swoop, consumer-grade VR was re-introduced to the world, and upon seeing just how far this transformative technology has come, hundreds of thousands have jumped into this burgeoning industry to help shape its future.

About This Book

VR, which was once only a plaything in tech laboratories or a research-and-development (R&D) experiment in large technology companies, has entered the mainstream consciousness. VR, and its technological cousin augmented reality (AR), are quickly proving to be the next pieces of transformational technology. Estimates vary wildly on just how big these markets might become, but many estimates place business revenue of VR and AR at over $100 billion by 2021, if not sooner.

Despite these eye-popping numbers, the VR and AR wave is still in its early stages. There is still ample time for consumers, content creators, even those with just a passing interest in learning how these technologies will affect their lives, to brush up on these technologies before the wave of mass consumer adoption hits.

In this book, I arm you with broad knowledge of the VR and AR fields, their histories, and where they appear to be headed in the future. VR and AR are vast areas of study, and many Fortune 500 companies are currently waging war to try to ensure that their interpretation of VR/AR is the winner. As such, I don’t try to make you an expert in one singular facet of the technology. Instead, I provide you with a broad knowledge base so you can confidently move forward into the fields of VR and AR as best fits your goals. I hope that the potential of these technologies will excite you enough to go out to experience and create content for them on your own.

Perhaps more than any technology wave in recent memory, the fields of VR and AR are in a state of constant flux. As such, much of the technology mentioned in this book is early-generation technology, and some might not even be released by time of publication. I’ve taken care to be as thorough as possible while generally focusing on technologies with an already released consumer product, but I would be remiss not to mention certain technologies that might or might not be widely available by the time this book reaches you. When covering the various hardware/
software options, I take care to mention upcoming technologies, but I give preference to technology that is already available to consumers.

While both VR and AR have a number of enterprise-level options available, I try to focus mainly on consumer-grade devices, as these devices are what the majority of consumers will interact with. However, as many current AR devices are targeted more towards enterprise consumption, I discuss those options in a bit more detail.

Finally, I try to keep things simple and clear in this book. For those who would like to explore the technologies in greater depth, I have included some more technical information within sidebars and marked with Technical Stuff icons scattered throughout the book. Those aren’t required reading, so feel free to skip them if you want to ignore the more in-depth technical pieces.

**Foolish Assumptions**

Without any knowledge of you, the reader, any assumptions I can make are most likely wrongheaded and foolish. However, I’ve thrown caution to the wind and assumed the following in order to outline the type of reader this book may appeal to.

The book assumes that you have at least a passing familiarity with VR and AR. You may have heard the terms being tossed about at work, or seen someone trying out a VR experience at a mall or retailer, or even had the chance to try out a headset yourself. You may have heard of Apple’s and Google’s recent forays into the AR space for mobile devices (ARKit and ARCore, respectively), and maybe you’re curious how you can try these experiences yourself.

The book also assumes you have an open mind regarding these technologies and are curious about where they’re headed in the future. Both VR and AR are very much emerging technologies in their (mass consumer) infancy. Some of the experiences and form factors available for both are very experimental and not always the polished experiences you may be accustomed to on your personal computers or mobile devices. Getting in on these technologies in their infancy allows you to follow their growth, missteps and all, which makes it all the more exciting when they succeed!

**Icons Used in This Book**

As you read through this book, you’ll see icons in the margins that call out blocks of information you may find important.
The Tip icon marks helpful advice for saving time and money or enhancing the experience as you begin to explore VR and AR.

The Remember icon calls out a key piece of information to retain or a summary of the points just made. If you remember nothing else from the section you just read, remember the material marked here.

Warning icons point out hazards, drawbacks, or gotchas.

Anything called out by this icon takes a deeper look at a particular technical detail. Feel free to skip this information if it doesn’t interest you.

Beyond the Book

In addition to what you’re reading right now, this product also comes with a free access-anywhere Cheat Sheet that includes some abbreviated explanations of the current state of VR and AR, use cases for VR and AR, and where VR and AR are headed in the future. To get this Cheat Sheet, simply go to www.dummies.com and type Virtual & Augmented Reality For Dummies Cheat Sheet in the Search box.

Where to Go from Here

You can jump to any chapter that interests you, and come back to revisit sections later as needed. If you’re an absolute beginner, I suggest reading Chapter 1 to establish a baseline for definitions of what the terms I use mean when discussing VR and AR. If you’re only interested in how you can use VR and AR today, Chapters 4 and 5 are a good starting point. And if you’re looking to take the step of creating your own VR or AR content, Chapter 6 should help guide your choice for further reading.

VR and AR have often been called the “fourth wave” of transformative technology after the personal computer, the Internet, and mobile computing. Each of those previous waves has uniquely shaped our lives to the point where we can’t imagine our lives without them. In this book, I help you examine how this “fourth wave” might change your life with the same effect as the first three waves. I hope you’ll walk away from this book excited about this new “fourth wave” of technology, with a strong knowledge base that you can use to make your own informed decisions on the technology or apply to your own projects as you create.
1
Getting Started with Virtual and Augmented Reality
IN THIS PART . . .

Understand the various terms, types, and histories of virtual and augmented reality.

Explore the current state of virtual and augmented reality’s form factors and features.

Review virtual and augmented reality’s adoption rates.
Chapter 1

Defining Virtual and Augmented Reality

When you picture “technology of the future,” what are the first things that come to mind? In ten years, how will technology be affecting your life differently than it does today?

Some people may picture self-driving electric cars that at a word automatically whisk them off to their desired destinations. Others no doubt envision an artificial intelligence (AI) utopia in which robots perform the menial labor tasks humans have had to do in the past, freeing people up to tackle life’s tougher problems.

Finally, many people may foresee a future where they’re able to create their own realities. They could be sitting on a couch at home but put on a headset and feel as if they’re at a soccer stadium thousands of miles away. They could put on a pair of high-tech glasses and have a fully realized holographic avatar of a friend appear to chat with them. They may even picture an entire room they could step into and dial up an environmental simulation as if they were actually there.

The average person may not have had a chance to experience this just yet, but nearly everyone can envision virtual reality (VR) and augmented reality (AR) as part of humanity’s future. And with good reason. For years, entertainment such as movies, TV shows, and books have been selling us on the promise of VR — the VR OASIS of Ready Player One, the VR real-world simulations of The Matrix, the
full-blown environmental re-creation of the holodeck from *Star Trek*. . . . All types of entertainment have their take on what has, up until very recently, been the stuff of magic and imagination.

The ideas of VR and AR themselves seem outlandish. Within the comforts of my own home, I can put on a headset and be anywhere? Experience anything? Be anyone? Attend live concerts or sporting events as if I were there? Fly across the sea and explore other countries? Travel through entire solar systems in minutes, jumping from planet to planet? These are the kinds of VR and AR that the public has long been promised. But until recently, that promise has fallen short of, well, *reality*.

Within the past few years, however, computing and manufacturing technologies have begun to catch up with the promises of VR and AR. What was once the purview of science-fiction has been brought to life. Science-fiction writer Arthur C. Clarke once claimed, regarding the wonders of new technology, “Any sufficiently advanced technology is indistinguishable from magic.” If you were to travel back in time and show an iPhone to a medieval peasant, he would think you were a wizard with a magical picture box. And today, many first-time users of high-end consumer VR headsets often describe the experience as nothing less than “magical.”

Within the next decade, we can expect massive changes in how we work, how we’re entertained, and how we communicate, all due to VR and AR. These technologies will fundamentally change where we’re headed as a society. But in order to do so, they need creators — dreamers, innovators, and magic makers — to help them reach their potential.

Before you dive into all the details of VR and AR, you need a basic overview of these technologies. This chapter helps you recognize the different types of VR and AR and provides you with some basic vocabulary for differentiating and discussing them. This chapter also provides a brief historical overview, so you can understand how we arrived at this current place in technological history. Finally, it explains the Gartner Hype Cycle, a way of understanding how technological innovations tend to grow and change, and how the Gartner Hype Cycle applies to emerging technologies such as VR and AR.

**Introducing Virtual Reality and Augmented Reality**

*Virtual reality* is often used as an umbrella term for all manner of immersive experiences, including many related terms such as *augmented reality*, *mixed reality*, and *extended reality*. In this book, however, when I refer to *virtual reality*, I generally
mean an immersive computer-simulated reality that creates a physical environ-
ment that does not exist. VR environments are typically closed off from the physi-
cal world in the sense that the environments they creates are wholly new. Although
the digital environments could be based on real places (such as the top of Mount
Everest) or imagined ones (such as the underwater city of Atlantis), they exist
apart from the current physical reality.

Figure 1–1 shows an example of a VR environment. It’s a screen shot of Wevr’s VR
experience, *The Blu*, which allows users to explore undersea coral reefs and ocean
depths, including an encounter with an 80–foot whale.

*Augmented reality* is a way of viewing the real world (either directly or via a device
such as a camera creating a visual of the real world) and “augmenting” that real-
world visual with computer–generated input such as still graphics, audio, or vid-
eos. AR is different from VR in that AR *augments* (adds to) a real–world or existing
scene instead of creating something new from scratch.

By strict definition, in AR, the computer–generated content is an overlay on top of
the real–world content. The two environments have no way of communicating
with or responding to one another. However, AR’s definition has been somewhat
co–opted in recent years to also include a more blended hybrid called *mixed reality*,
in which interaction can occur between the real world and digitally augmented
content.
In this book, when I refer to *augmented reality*, I use it as a blanket term that includes mixed reality as well. The two terms are often used synonymously within the industry as well, with *mixed reality* rapidly gaining favor as the more descriptive term for the combination of analog and digital realities.

Figure 1–2 shows an example of one of the most popular recent examples of AR, Pokémon Go, which places a digital Pokémon character within your real-world environment.

**THE THIN YELLOW LINE**

For the past 20 years, millions of people have been exposed to a flavor of AR every Saturday and Sunday, although they may not realize it. In 1998, the 1st & Ten line was introduced by a company called Sportvision to digitally visualize the first-down line for the casual football fan.

In order to achieve this effect, Sportvision creates a virtual 3D model of the football field. While capturing video of the game, each real-world camera also transmits its location, tilt, pan, and zoom values to powerful networked computers. Using these values, the computers can determine exactly where each camera sits within the virtual 3D model of the field and can use a specialized graphics program to draw the line on top of the video feed.

Drawing that line is more complicated than you may think. If the line were simply overlaid on top of the video feed, any time a player, referee, or ball passed over where the line was overlaid, the person or object would appear “under” the digital representation of the line. This would lead to a very poor viewing experience.

In order to make the digital line appear to display under various people and objects, the software uses one color palette for colors that should appear as part of the field and another color palette for colors that should appear on top of the line. When it draws the digital line onto the video feed, the field color palette colors are converted to yellow where the line should appear, whereas colors in the other color palette are not converted, leading the people and objects to appear on top of the digital line.

This encompasses AR in a nutshell — a real environment (the football field) has been augmented with digital information (the yellow line) to enhance users’ viewing experience in a way that feels natural to the viewers.
Looking at Some Other Types of Virtual and Augmented Reality

VR and AR are still in their relative infancy, so it’s difficult to know which terms will fall out of favor over time and which terms will stick around. The terms *virtual reality* and *augmented reality* may have staying power, but you should also be aware of some of the other terms out there.

**Mixed reality**

*Mixed reality* (MR) may take your view of the real world and integrate computer-generated content that can interact with that view of the real world. Or it may take a fully digital environment and connect it to real-world objects. In this way, MR can sometimes function similarly to VR and sometimes function similarly to AR.

In AR-based MR, the content of the digital world is no longer passively laid on top of the real world; instead, it can act as if it were a *part* of the real world. Digital objects appear as if they existed in the physical space, and you can even interact with some digital objects as if they were actually there. For example, you might be able to drop a digital rocket onto your coffee table and watch it blast off, or bounce a digital soccer ball off the real-world walls and floor.
Apple’s ARKit and Google’s ARCore, while described as AR, actually straddle the line between AR and MR and reveal the naming discrepancy occurring within the industry. Although they project a digital layer on top of the physical world, they’re also able to scan the environment and track surfaces within the real world. This enables users to place digital objects in the real world, cast digital shadows on real-world items, affect digital lighting according to the real world’s lighting conditions, and so on — all things that lean more toward the definition of MR.

Another example of a current AR-based MR headset is the Microsoft HoloLens (shown in Figure 1-3), a headset that scans the physical environment to mix in digital objects. This technology, which is also found in Microsoft’s Meta 2, takes things a step further than the current tablet-based offerings from Apple and Google. It projects the digital environment onto translucent visors and enables your hands to interact with those digital objects as if they were physically there.

FIGURE 1-3: Microsoft HoloLens headset hardware.
In other MR instances, you may only see a completely digital environment with no view of the real world, but that digital environment is connected to real–world objects around you. In your virtual world, real–world tables or chairs may digitally appear as rocks or trees. Real–world office walls may appear as moss–covered cave walls. This is VR–based MR, sometimes called augmented virtuality.

Following their strict definitions, AR provides no interaction with the augmented digital world, whereas MR does allow such interaction. However, these strict definitions are becoming blended in the industry. Often mixed reality and augmented reality are used as synonyms within the industry. Their meaning over time will likely grow and change. In this book, I use AR and MR synonymously, unless otherwise noted.

Augmented virtuality

A term that has yet to gain much traction within the industry, augmented virtuality (AV), also sometimes called merged reality, is essentially the inverse of typical AR. Whereas AR refers to predominantly real–world environments that have been augmented with digital objects, AV refers to predominantly digital environments in which there is some integration of real–world objects. Some examples of AV include streaming video from the physical environment and placing that video within the virtual space or creating a 3D digital representation of an existing physical object.

Figure 1–4 shows an example screenshot of AV through Intel’s recently defunct Project Alloy. Using 3D cameras, Intel was able to bring in interactive imagery of physical real–world objects (such as your hands) into its virtual environments.
Extended reality

*Extended reality* (XR) is the umbrella term for the entire spectrum of technologies discussed thus far (including VR, AR, and AV).

The *virtuality continuum* is a scale used to measure a technology’s amount of realness or virtualness. On one end of the scale is the completely virtual, and on the other end is the completely real. XR spans the full spectrum of this scale, from end to end.

Figure 1–5 shows where these terms fall on this scale developed by technology researcher Paul Milgram in the 1990s. Remember, though, that MR and AR, while separated in this chart for definition’s sake, are often used synonymously to refer to the spectrum that MR is shown covering here.

In this book, I mainly focus on two terms — *virtual reality* and *augmented reality* — and the technological areas that they cover. Those two terms encompass most scenarios. I use *virtual reality* to refer to any hardware/software combination that creates a mostly or entirely digital experience. I use *augmented reality* to refer to any real/physical environment to which digital elements have been added (which may or may not interact with the real environment).

Taking a Quick History Tour

In 1935, a short story called “Pygmalion’s Spectacles” by American science-fiction writer Stanley G. Weinbaum told the tale of a professor who invented a pair of goggles that enabled a user to trigger “a movie that gives one sight and sound . . . taste, smell, and touch . . . You are in the story, you speak to the shadows (characters) and they reply, and instead of being on a screen, the story is all about you, and you are in it.” Weinbaum’s writing pre-dates computers and nearly pre-dates the invention of television. If Weinbaum were to travel to the present and see just how closely his vision of VR resembles that of the emerging technology of today, he would probably be shocked.
Both VR and AR have an incredibly rich and diverse history, far too deep to fully cover here. However, a general overview of some of the various incarnations of these technologies may provide some insight into where the technologies may be headed in the future.

The father of virtual reality

In 1955, a cinematographer named Morton Heilig, considered the father of VR, imagined a multisensory theater called “The Cinema of the Future.” Heilig created the Sensorama (see Figure 1-6), an arcade-style mechanical cabinet built to stimulate the senses, for which he then developed a number of short films. It included many of the features prevalent in modern-day VR headsets, such as a stereoscopic 3D display, stereo speakers, and haptic feedback through vibrations in the user’s chair.

Shortly after inventing the Sensorama, Heilig also patented the Telesphere Mask, the first-ever head-mounted display (HMD), which provided stereoscopic 3D visuals and stereo sound. This (relatively) small HMD more closely resembles today’s consumer VR headsets than the bulky seated form factor of the Sensorama.
The patent image shown in Figure 1–7 bears a striking resemblance to many of the headsets available today.

![Figure 1-7: The Telesphere Mask patent. Source: https://patents.google.com/patent/US2955156A/en](https://patents.google.com/patent/US2955156A/en)

**Augmented reality gets a name**

In 1990, Tom Caudell, an employee at Boeing Computer Services Research, was asked to create a replacement for Boeing’s current system of large plywood boards with wiring instructions for each aircraft being built. Caudell and his co-worker David Mizell proposed a head-mounted display for construction workers that superimposed the position of cables through the eyewear and projected them onto multipurpose, reusable boards. Instead of having to use different boards for each aircraft, the custom wiring instructions could instead be worn by the workers themselves. Caudell and Mizell coined the term *augmented reality* for this technology.

**Early virtual reality failures**

In 1993, Sega, a videogame company riding high on the release of its massively popular Sega Genesis, announced the Sega VR headset for the Sega Genesis at the Consumer Electronics Show (CES). Sega originally intended to deliver the device for $200 in the fall of 1993, a moderately affordable price point at the time. However, the system was plagued by development difficulties and was never released to the public. Sega’s CEO at the time, Tom Kalinske, said that the Sega VR was shelved due to testers developing painful headaches and motion sickness — an unfortunate first foray into consumer gaming VR.