

Virtual reality

 **Products liability**

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About Markel's Risk Solution Services team

Risk Solution Services provides technical insight related to existing and potential insured risk at Markel. The team partners with our customers, claims, and underwriters to educate on both current and future risk trends and supports our clients with a comprehensive offering of risk management solutions.

We do this by engaging with clients, underwriting, and claims teams.

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What is virtual reality?

Virtual reality (VR) refers to an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment. In reality, human brains interpret visual cues, such as light reflected on objects in the environment, and relative size and shadows, as well as auditory stimuli, for perception. Typical equipment that may be included in VR are head-mounted displays (HMDs), immersive rooms, suites or simulators, data gloves, and wands (usually wireless). VR headsets and other components are typically sold through retailers such as Target and/or online from Amazon, Target, BestBuy, etc. The first mind-controlled VR game is expected to be in arcades in 2019.

Through the use of specific hardware and software, VR can help replicate or create an environment, based on reality or the imagination of the creator. To experience VR, a user needs a set of hardware. The most important and common device is a head-mounted display (HMD), which is a wraparound headset that keeps real world light and images out of view. VR developers use visual cues and 'rules' to provide information for the brain in a VR experience. For example, in a virtual environment, objects should follow expectations of the laws of physics, and shadows and size should aid in determining depth and distance.



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VR defined

VR-related products were introduced more than 100 years ago. In the 1920s, flight simulators were developed to train US military pilots. In the 1960s, the Sensorama, a VR theater cabinet was introduced, and the first HMD system for immersive simulation applications was developed. The public starting accessing VR devices through arcade games and early 3D graphic games in the 1990s. However, HMDs were not popularized until after 2010, when the prototype of the Oculus Rift, an HMD developed specifically for gaming, was created. Since that time, numerous companies have developed their own VR headsets.

It should be remembered, VR is a computer-generated 3D simulation using electronic equipment to be interacted with by humans in a seemingly real or physical way. There are many current definitions of VR. However, Techopedia appears to cover most of the others. According to Techopedia, “Virtual reality refers to computer-generated environments or realities that are designed to simulate a person’s physical presence in a specific environment that is designed to feel real. The purpose of VR is to allow a person to experience and manipulate the environment as if it were the real world. The best virtual realities are able to immerse the user completely. Virtual reality should not be confused with simple 3D environments like those found in computer games, where you get to experience and manipulate the environment through an avatar, rather than personally becoming part of the virtual world.” Further, “The environment must be made up of images that appear life-sized according to the perspective of the user/viewer unless the desired effect deviates from this. The system responsible for running the virtual environment must be able to track the user’s motions, especially the eye and head movements, so that it can react and change the images on the display or initiate any related events.



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Immersing the user

In order to immerse the user fully, Jonathan Steuer, a Ph.D. in communication theory and research, proposed two components. Depth of information: refers to the quality and amount of data the user is fed by the virtual environment itself. This could be achieved through the display resolution, graphics quality, and complexity of the environment, sound quality, haptic feedback, and the like; and breadth of information: refers to how many senses are being stimulated by the virtual environment. The most basic of these should be audio and visual, while the most advanced systems should include stimulation of all five senses in order to enhance immersion.



Visual perception is the brain's ability to make sense of what the eye sees, through interpretation of light reflected on objects in the environment. Visual cues, such as relative size and shadows, aid in interpreting the world. Through the use of specific hardware and software, virtual reality (VR) can help replicate or create an environment, based on reality or the imagination of the creator. The aim of VR is to create a sensory experience for the user sometimes including sight, touch, hearing, smell, or even taste. To experience VR, a user needs a set of hardware. The most important and common device is a head-mounted display (HMD), which is typically a wraparound headset that keeps real world light and images out of view. VR developers use visual cues and 'rules' to provide information for the brain. For example, in a virtual environment, objects should follow expectations of the laws of physics, and shadows and size should aid in determining depth and distance.

The interaction between VR and the brain has led to various applications, including military, consumer, and medical applications. The first wide-scale consumer applications for VR are in the computer gaming industry. In health and medicine, example applications include treatment of post-traumatic stress disorder, surgical training, and physical therapy. Additionally, VR is being promoted as an educational tool, replacing traditional books and providing virtual field trips and training simulations. VR can be used in private settings, such as an office, workplace or home, or a public setting, such as a VR arcade.

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Adverse effects on the user

The use of HMDs and VR equipment comes with some risks. Users may experience the following types of adverse effects during or following a VR experience:

- Slips, trips, falls
- Cord, cable, and controller entanglement
- Discomfort from static posture requirements or from wearing the HMD
- Repetitive stress injuries
- Photosensitive seizures
- Hearing loss
- Radio frequency interference
- Eye strain or fatigue
- Increased heart rate, increased blood pressure, panic attacks, anxiety, post-traumatic stress disorder, fainting, nausea, vomiting, or other physical or psychological effects
- Without a cross-platform standard, VR and AR applications, games, engines, and devices must use each VR/AR platform's proprietary APIs (i.e., each platform can only use the apps and devices that have been specifically ported). The result is high development costs, industry fragmentation, and confused customers--limiting market growth.
- Many of the consumer applications of VR are in the gaming industry. Recently, the World Health Organization classified disorders related to gaming in the ICD-11, including 6C51, gaming disorder (associated with addictive behaviors), and QE22, hazardous gaming, which increases the risk of harmful physical or mental health consequences to the individual or others around the individual.
- Research on how VR gaming influences perceptions, cognitions, and behaviors outside of playing is ongoing. Gamers may experience Game Transfer Phenomena (GTP), or non-volitional phenomena related to playing videogames including thoughts, urges, images, and sounds when not playing.
- There is research suggesting that exposures to VR environments can increase dissociative experiences or senses of detachment and unreality toward oneself or the external world.



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- Ocular effects have been noted in young adults wearing VR headsets. The American Academy of Ophthalmology (AAO) notes that “there is no reason to be concerned that VR headsets will damage eye development, health or function.” However, staring at a VR headset screen, as with other digital devices, may cause eye strain or fatigue. Individuals with amblyopia (an imbalance in visual strength between the two eyes), strabismus (misaligned eyes), or other conditions that inhibit focusing, depth perception, or normal 3D vision may be more likely to experience headaches and/or eye fatigue when using VR gear. The AAO recommends that those who wear glasses should wear them while using a VR headset.

Because the widespread use of VR technology is recent, there is limited information regarding the potential side effects associated with sustained use of VR equipment. These uncertainties have resulted in numerous warnings on equipment that are inconsistent between products.



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Issue for underwriters to consider

Issues to consider include:

- Augmented Reality (AR) and Virtual Reality (VR) are typically being combined with other technologies to intensify the overall VR experience. While virtual reality is described as interactive, immersive, compelling, genuine, with both an initial “wow” factor and endless replay ability the sheer act of wearing a headset means the participant is cut off from the distractions of the real world and fully immersed, while attempted to be fully focused in the VR presentation. Emotions can be more intense and more genuinely felt when compared to traditional video. AR adds an additional advancement element to certain components like sound, picture and images, and motion along with GPS data to make the view more alluring meanwhile informative. It blurs the line that makes the difference about what is computer generated and what is real by improvising the users’ senses. Generally, augmented reality represents a changed view of reality by augmenting the elements or components in context to the environment. With the help of AR technology combined with VR, users find themselves in the middle of a digitally-manipulating and interactive surrounding that can be masked into the real world.
- Products should meet applicable regulatory or consensus standards. Some include:
 - The Khronos Group VR Standards Initiative (an industry consortium of leading hardware and software companies which has as a goal ANSI Standards for VR)
 - ISO 9241-171 Ergonomics of human-system interaction -- Part 171: Guidance on software accessibility
 - ISO 9241-391:2016 Ergonomics of human-system interaction -- Part 391: Requirements, analysis, and compliance test methods for the reduction of photosensitive seizures
 - Web Content Accessibility Guidelines (WCAG) 2.3: Do not design content in a way that is known to cause seizures
 - ANSI/HFES 200-2008: Human Factors Engineering of Software User Interfaces
 - CAN/CSA-C22.2 No. 60950-1-07 Second Edition, Information Technology Equipment Safety
 - IEC/EN 62471 for LED Lighting Products Standards for Eye and Skin Safety
 - IEEE Standard PAR1789: Recommending practices for modulating current in high brightness LEDs for mitigating health risks to viewers, and Update: LED Lighting Flicker and Potential Health Concerns
 - Title 47, Part 15 (47 CFR 15), part of Federal Communications Commission (FCC) rules and regulations regarding unlicensed transmissions
 - ETSI EN 300 328 V1.9.1 (2015-02) Electromagnetic compatibility and Radio spectrum Matters (ERM)
 - EU Radio Equipment Directive (RED) 2014/53/EU

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- Product labeling should include clear warnings. Instructions and warnings should be provided on products and manuals. Examples of warnings obtained from VR products include:
 - Virtual reality is an immersive experience that can be intense. Frightening, violent, or anxiety-provoking content can cause your body to react as if it were real. Carefully choose your content if you have a history of discomfort or physical symptoms when experiencing these situations.
 - We recommend seeing a doctor before using the headset if you are pregnant, elderly, have pre-existing binocular vision abnormalities or psychiatric disorders, or suffer from a heart condition or other serious medical condition.
 - If you previously have had a seizure, loss of awareness, or other symptom linked to an epileptic condition, you should see a doctor before using the headset.
 - This product should not be used by children under the age of 13, as the headset is not sized for children and improper sizing can lead to discomfort or health effects, and younger children are in a critical period in visual development.
 - Prolonged use should be avoided (by children greater than 13), as this could negatively impact hand-eye coordination, balance, and multi-tasking ability. Adults should monitor children closely during and after use of the headset for any decrease in these abilities.
 - Make sure the headset and sensor cables are not choking or tripping hazards.
 - Take at least a 10 to 15 minute break every 30 minutes, even if you don't think you need it. Each person is different, so take more frequent and longer breaks if you feel discomfort. You should decide what works best for you.
 - Listening to sound at high volumes can cause irreparable damage to your hearing. Background noise, as well as continued exposure to high volume levels, can make sounds seem quieter than they actually are. Due to the immersive nature of the virtual reality experience, do not use the headset with the sound at a high volume so that you can maintain awareness of your surroundings and reduce the risk of hearing damage.

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- Immediately discontinue using the headset if any of the following symptoms are experienced: seizures; loss of awareness; eye strain; eye or muscle twitching; involuntary movements; altered, blurred, or double vision or other visual abnormalities; dizziness; disorientation; impaired balance; impaired hand-eye coordination; panic or anxiety attack; excessive sweating; increased salivation; nausea; lightheadedness; discomfort or pain in the head or eyes; drowsiness; fatigue; or any symptoms similar to motion sickness.
- The headset, touch sensor, and remote contain magnets or components that emit radio waves, which could affect the operation of nearby electronics, including cardiac pacemakers, hearing aids, and defibrillators. If you have a pacemaker or other implanted medical device, do not use these devices without first consulting your doctor or the manufacturer of your medical device.
- A review of headset manufacturers notes differences in warnings between companies. For example, one company notes that the device is not for use by children without adult supervision; another company notes that the product was not designed to be used by children (no age noted) and that children should not be allowed to play with it; and a third notes that children under the age of 13 should not use the product.
- Some products come with maintenance instructions, including proper grounding installation, battery replacement instructions, and instructions on cleaning the product.
- Some products contain batteries and lasers, and have restrictions regarding disposal.



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Injury statistics

There is little data on injury statistics related to VR. Many types of physical injuries may occur during a VR experience. In addition, experiences such as dizziness or fatigue may lead to injury following a VR experience. While warnings are provided with some devices warning of the operation of heavy machinery immediately following a VR experience, the frequency of injury following VR headset use is unknown. The CPSC highlighted hazards associated with VR and augmented reality AR (AR, or mixed reality) in a 2017 report and notes, “VR replaces the visual field of the consumer with a digital environment. Because the user’s view of the physical world is replaced with a digital world, the possibility of falls, trips, and bumping into real objects exists. If a user attempts to lean on a virtual object, or “sees” a hallway where a physical wall or a stair exists, an injury may occur. To the extent that VR headsets are heavy, or may contain high-energy batteries, there could be a risk of neck strain or fire/burn in the case of a sudden release of the battery’s energy... Bright, moving, or human-shaped virtual objects can distract an AR system user while he/she is performing an important task, such as crossing a street... Similar to VR, the AR environment can contribute to the possibility of falls, trips, and bumping into real objects.”

- **VR has known physical and psychological risks:** Risks include physical injury associated with slips, trips, falls, entanglement, as well as potential for eye strain and hearing loss. Many users experience effects of motion sickness, including nausea. Other physical or psychological effects may include seizures, loss of awareness, eye strain, eye or muscle twitching, involuntary movements, altered, blurred, or double vision or other visual abnormalities, dizziness, disorientation, impaired balance, fainting, impaired hand-eye coordination, panic or anxiety attack, post-traumatic stress disorder, excessive sweating, increased salivation, nausea, lightheadedness, discomfort or pain in the head or eyes, drowsiness, and fatigue.
- **VR side effects may last well after the VR experience:** Headaches, nausea, and visual effects may linger following a VR experience, introducing increased risk for injury. Users should not operate heavy machinery if any VR side effect symptoms persist.
- **VR’s side effects may affect children’s visual development:** The American Academy of Pediatrics has not provided guidance on VR use by children; however, there is mixed evidence regarding the safety of VR headset use by children. The American Academy of Ophthalmology (AAO) notes, “There is no reason to be concerned that VR headsets will damage eye development, health or function.” However, a printed warning on a VR HMD notes that children under the age of 13 should not use it, as younger children are in a critical period in visual development.

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- **VR's side effects may affect other sensitive populations to a greater degree:** There may be a greater risk of adverse effects for people who are pregnant, elderly, have pre-existing binocular vision abnormalities, have psychiatric disorders, or suffer from a heart condition, epileptic condition, or other serious medical condition.
- **Continuous VR exposure may increase the risk of adverse effects:** Manufacturers of VR hardware recommend taking regular breaks while using VR equipment.
- **Heavy use of VR equipment for gaming applications may have unique risks:** Gamers may experience Game Transfer Phenomena (GTP), or non-volitional phenomena related to playing video games including thoughts, urges, images, and sounds when not playing. Gaming activity could be associated with a gaming disorder. The World Health Organization (WHO) classified disorders related to gaming in the ICD-11, including 6C51, gaming disorder (associated with addictive behaviors), and QE22, hazardous gaming, which increases the risk of harmful physical or mental health consequences to the individual or others around the individual.
 - **Frequency** – Frequency is likely high for injuries such as nausea, headaches, pinches, abrasions, lacerations, dizziness, and minor falls. Less frequent injuries could include shock, falls from heights, major trauma, and death. There have been recorded incidents of users walking full-speed into walls, being spatially unaware, jumping into ceilings, walking on balconies on high rise buildings, and being in kitchens with headsets on.
 - **Severity** – Injury and death are possible outcomes especially in the fall from height scenario and for older users who may experience even minor falls.



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