Top 10 Virtual Reality Best Practices

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INTRODUCTION

Few would have imagined a trip to moon from their office, treating someone who fears flying in a virtual reality (VR) headset, or "swimming" with whales in the deepest waters of the ocean from their classroom, yet, today we can do all of these things and much more in VR.

We define VR to mean the ability to create environments, real or imagined, stimulating **a sensory experience that invites one to immerse and interact**. The radically new experiences VR provides today, has been decades in the making. Globally, analysts project VR will transform into a multi-billion dollar industry in the next decade.

We are a group of technologists, journalists, business leaders, entrepreneurs, visual artists, immersive sound technicians, and storytellers representing The VR/AR Association (The VRARA). The VR/AR Association (The VRARA) is an international organization with thousands of active members and over 30 global chapters with a mission to accelerate collaboration in the rapidly developing virtual reality and augmented reality ecosystem to promote research, education and the development of industry standards in this nascent but rapidly developing field. It is comprised of 24 committees focused on specific technologies and applications.

This report is our effort to capture into one source the rapidly evolving knowledge about VR. We seek to present the hardware, the software and to dig into the specifics of the development and content production. We see this as an opportunity for practitioners and stakeholders to add their experience and knowledge. As a committee we intend to update this material every six months.

We encourage industry feedback to keep this a living document.

The VRAR Stories and Audience Committee
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What is VR? Does it have to be computer generated? Does it include 360 video, must it be viewed in a headset, does it count to be able to access on your device? Must it be interactive? There are many questions, and great debates as the technology evolve, and we learn how to successfully create content that engages audiences. It's impossible to have all the answers, so we have attempted to lay out the landscape for which we are operating today.

Let's start at the beginning. Dr. Ivan Sutherland, referred to as the father of computer graphics and is credited with building the first VR headset with his student Bob Sproull in 1968. The inventor and computer scientist gave it a name, "The Sword of Damocles." And perhaps we should note the name, as it represents themes based on the story about Roman gods who get themselves in trouble when they were granted great powers. For our purposes, Wikipedia is a good source of insight, explaining how it may relate to VR: "The sword of Damocles is frequently used in… epitomizing the imminent and ever-present peril faced by those in positions of power. More generally, it is used to denote the sense of foreboding engendered by a precarious situation, especially one in which the onset of tragedy is restrained only by a delicate trigger or chance."

VR is powerful technology, and thus, we must respect the potential for all kinds of impact. It can create environments, real or imagined, stimulating a sensory experience that invites one to immerse and interact. Augmented reality (AR) is where images overlay onto real world objects. For example, many attribute Niantic's Pokémon GO as the first breakout mobile application in AR. Though this document focuses on VR, for context we believe it is important to understand the difference.

VR blocks out the real world using a head-mounted display (HMD) and the user can only see the virtual world. This creates, what the industry refers to as "presence" or "immersion;" which is the perception of being physically present in a nonphysical world.

In the decades following Dr. Sutherland's invention, many companies and universities such as Sega, Nintendo, and MIT have been actively researching and exploring VR; with a few devices making it to market. Because the development of computer graphics and memory were in their infancy at the beginning, basic computing power

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was not able to deliver consistent and functioning experiences, thus industry traction moved slowly. Things took a sharp turn in 2011, when Valve launched a vastly improved VR headset which was quickly followed in 2012 by the Oculus Kickstarter project. Together, they spawned a new commercial day in VR.

In modern history, the gaming industry has been first to market with consumer friendly entertainment technology. As a mature industry, they have motivated loyal consumers, providing leverage to new technologies. However, while gaming is a strident force in VR, immersive technology applications expand vigorously into just about every sector and industry imaginable, in material ways.

Today, VR applications are currently in use or development across sectors, among others: architecture/real estate/construction, e-commerce/retail, education, industrial manufacturing, fashion, media/entertainment, medical/healthcare, tourism, space industry and the military. For example, NASA and globally, militaries have been using VR for many decades for training and development. Many universities are using VR in education in general. In particular, medical students and psychologists recognize an increasing number of applications for VR from PTSD, social anxiety, speech disorders, and other health issues.

There are multiple access points to VR (mobile, PC, and Standalone). Each facilitates specific types of experiences with varying degrees of immersion, presence, and agency.

Mobile VR consists of headsets such as Google Daydream, Samsung Gear VR, and a wide variety of Google Cardboard type viewers. The cardboard experiences tend to limit motion and head tracking, field of view and lack the ability to use hands and feet in the experience.

However, Mobile VR is ideal for casual VR gaming, virtual tours, experiencing 360-degree video and 360-degree photography. It is also inexpensive (excluding the cost of the phone) and easy to get started. It is important to note here that content development costs will vary depending on the type of hardware the user employs.

PC or console based VR (i.e. PlayStation PSVR) is designed for a richer immersive experience. Due to the processing power of PCs, as well as, controllers and

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peripherals (e.g. hand controllers), the experiences create a far greater feeling of "being there" for the user; a powerful feeling of presence. The head and motion tracking are more accurate and flexible for the users thereby allowing them to feel truly immersed.

Haptic feedback and the use of the participant's own hands add to the experience and to the use cases that PC VR offers. Haptic means the ability to touch and manipulate objects using a part of your body, say a hand or foot. PC VR is ideal for simulations - enterprise training and higher education, high-end AAA VR gaming, exceptional media experiences, and visualization for design.

Standalone VR is a next generation type VR experience that will be brought to market by Google's Daydream initiative; with planned devices, initially from HTC Vive and Lenovo. It is fair to assume these will offer an experience directly between mobile and PC. Ideally, as the technology advances, the idea of not being "tethered" to a PC, but having extended capabilities will open the door for many more use cases.

The goal of virtual reality is to create an immersed experienced in a virtual, a computer-generated, world that focuses on providing the user a sense of presence. HMDs and CAVE are the main VR technologies.

Virtual Reality Development Hack in Canberra at the Australian Aid's InnovationXchange October 6, 2016
Courtesy of SecondMuse

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Monetizing VR is a critical question for which there is little data in understanding what will be primary drivers of revenue. Currently, tech and manufacturing companies are spending tens of millions of dollars on developing hardware and software. On the content side, marketing budgets have been an enormous source of funding for content development and production.

To date, the focus has been on creating novel experiences for enterprise client and consumer use, but it is not revenue that will ultimately build an industry as it becomes less novel and the rate of return uncertain. There is tremendous experimentation, given the serious challenges of distribution of hardware, software and lack of an established platform. Some content providers see revenues from licensing, while on the enterprise side there are some standard offerings as full-scale creation and production solutions develop. A tangible shift of revenue streams will come when it becomes abundantly clear how VR aligns with core business across the many industries listed above; whether it be training, education or value add to product and services.

When corporates, especially Fortune 100 companies, decide to take on VR as a business unit (see Facebook, HTC, Samsung, etc.) we are likely to see the acceleration of complete ecosystems at all levels of industry, from technologists, platform creators to distributors to producers and users.

For example, when a major corporation decides to invest in a VR business unit, it sets off a chain of events. That will include the need for talent and building teams to increased product development, which in turn will generate economic value by driving technology forward promoting engaging content on innovative platforms for consumers.

The industry has seen explosive growth in record breaking investments in the billions, the creation of multiple types of headsets, and a burgeoning start-up ecosystem that continues to push the boundaries of VR technology, platforms, and content. Once the mass adoption begins, that we expect, across multiple industries, we believe we will start experiencing VR as a societal norm. This will drive ROI up and subsequently fuel the industry to reach market shaping size.

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VR content came fast and furiously in 2014, heavily driven by early VR pieces by creators like Nonne de la Penna of Emblematic Group and Chris Milk, founder of Within. One of his early VR experiences was in partnership with the United Nations, Clouds over Sidra, set in a Syrian refugee camp, following the life of a 12 year old girl named Sidra.

From the United Nations, to the World Bank and the Australian Aid program, development agencies are among the first out of the gate that have been experimenting with immersive VR/AR technologies. The purpose has been to build empathy and educate local communities as they work to improve the challenging environments surrounding them. There is a commitment to understanding how new communication technologies can be accessed and leveraged by individuals in developing nations to inspire positive change, and help create bridges between otherwise disconnected human experiences.

Tanzania's Sustainable Aquaculture Innovations

Making Waves: Re-engineering Aquaculture in Tanzania, is a 360/VR story produced in collaboration with the Australian Aid program's innovationXchange and SecondMuse. The story showcases the work of several aquaculture innovation projects and initiatives that seek to innovate in the aquaculture industry around the world Starting in Zanzibar, producers documented the SeaPoWer project that helps women seaweed farmers adapt their businesses for rising sea-level temperatures and changing environmental conditions. In Dar es Salaam, they filmed the work of The Recycler, a company that uses insect larvae as a critical ingredient in the fish meal at the Indian Ocean Aquaculture tilapia farm. By using black soldier flies to replace wild-caught fish as feed, these projects are protecting our oceans and creating jobs that fuel Tanzania's aquaculture sector.

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Virtual Reality Development Hack in Canberra at the Australian Aid's InnovationXchange October 6, 2016 Courtesy of SecondMuse

Lessons

The female seaweed farmers you see in the above screenshot is from Tanzania and watching an underwater Jaunt VR film called Valen's Reef. They are most in awe of the ability to be underwater. Swimming, even for them, is not very common. And for some of the women who have dedicated their lives to marine science, this was a perspective that they may have never seen before. 360 versus fixed frame seemed to give them a whole new perspective on the world beneath the surface.

There has been much written about the pieces themselves, and we would like to unpack conceptional points and approaches. No matter how powerful the film (even if it features charismatic characters, evocative storylines and an unambiguous moral stance) the key to producing an effective VR experience lies in an integrated approach from the VR production to the parallel elements.

Going beyond the "click to donate" button, social impact VR/AR needs to drive the user into an immersive experience and perspective usually not easily achievable without the technology. In other words, it is vital to answer this question: why this material should be in VR versus any other medium?

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A few critical best practices we have
discovered and aggregated for social impact in VR:

Point of View
As in many VR stories, POV is critical to social impact in VR.

Environment and Surrounding
Social Impact requires that the VR or 360° video experience happens within a photo-realistic and preferably a real-time environment for the users to be able to engage and attach themselves to the impact the story is asking them to make. For example, if you are working on an Ocean conservation VR experience and or film, it is good form to shoot on location and or generate a photo-realistic environment of the ocean for the audience/user to engage their emotional cues to something that they believe is real outside of the experience.

Reality outside of the headset
Social Impact VR experiences are focused on the human element, intended to connect on an emotional level which in turn increases the odds of a user being inspired to act. It is pivotal that the end user understands these stories/issues exist in the real world and the VR headset is serving as a proxy. Social impact VR needs to present at a minimum, a real world action the user can take in addressing this problem/issue. This might be a donation, an action, and/or behavioral shift that is measurable.

Empowering local content creation
Understanding how simple, accessible, and low-cost consumer hardware can be leveraged by people in a non-western context by focusing on and encouraging the capacity building aspects of the medium. We believe that storytellers everywhere should have access to immersive storytelling tools, and that they don't need cinema-grade cameras and teams of people to produce compelling, impactful content. For instance, creating immersive stories through the lens of local social innovators documenting how sustainable solutions can improve the health of their communities.

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Overview Effect

Best practices suggest targeting an overview effect. The overview effect is defined as a cognitive shift in awareness. It was first reported by some astronauts and cosmonauts during spaceflight; often while viewing the Earth from orbit. “It refers to the experience of seeing firsthand the reality of the Earth in space, which is immediately understood to be a tiny, fragile ball of life, ‘hanging in the void,’ shielded and nourished by a paper-thin atmosphere. From space, national boundaries vanish, the conflicts that divide people become less important, and the need to create a planetary society with the united will to protect this ‘pale blue dot’ becomes both obvious and imperative.”

VR Pavilion at the World Ocean Festival on Governors Island in New York featuring Making Waves: A 360/VR film featuring aquaculture innovators in Tanzania Courtesy of Matt Scott

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Stories are as old as humanity. Since there were campfires, there have been people sharing experiences. What has changed significantly are the tools we have to tell those tales from, books, plays, radio, film, video and now immersive technologies in VR and others. Many aspects of storytelling within VR/AR environments remain true and carry over from past innovations.

The principles of theater provide many sustaining principles for VR. Stories, which can be broken down in many ways, but for the stage and film, these are truisms: establishment of characters and plot. Successful storytelling, regardless of medium or device, must invite the user or viewer into the experience, and continuously provide the stimulation needed to keep a user's curiosity engaged throughout. Stories may have a call to action, or simply to entertain, like gaming or film/video. The stories may be features or episodic, with no clear-cut ending.

The art of building narratives around characters in VR/AR needs to be considered within the greater view of interactive drama, of which the latest evolution can be found in virtual reality.

A commonly used word in connection with virtual reality experiences is 'agency', but the meaning of the word is often only explored on a surface level. The idea of agency is that interactivity gives us the ability to impact the world we are immersed in. Interactivity then is the means by which we can empower a viewer (user) to change the narrative experience (narrative discourse) or simply put make choices about the evolution of that experience.

We might think of this as the narrative paradox - on the one hand interactive freedom is afforded to users able to participate actively in shaping a narrative, while on the other the demand for a coherent and satisfying narrative structure requires authorial creation and control.

360-video and real-time VR applications may be distinctly different in creation, but the understanding is that they both to varying degrees allow for the user to be a spectator and a player - they are the audience but also a character. This dual role is the key to building a successful narrative in VR as you should block, choreograph and script to accentuate these multiple identities. (Tash Tan, S1T2 [working with Davar

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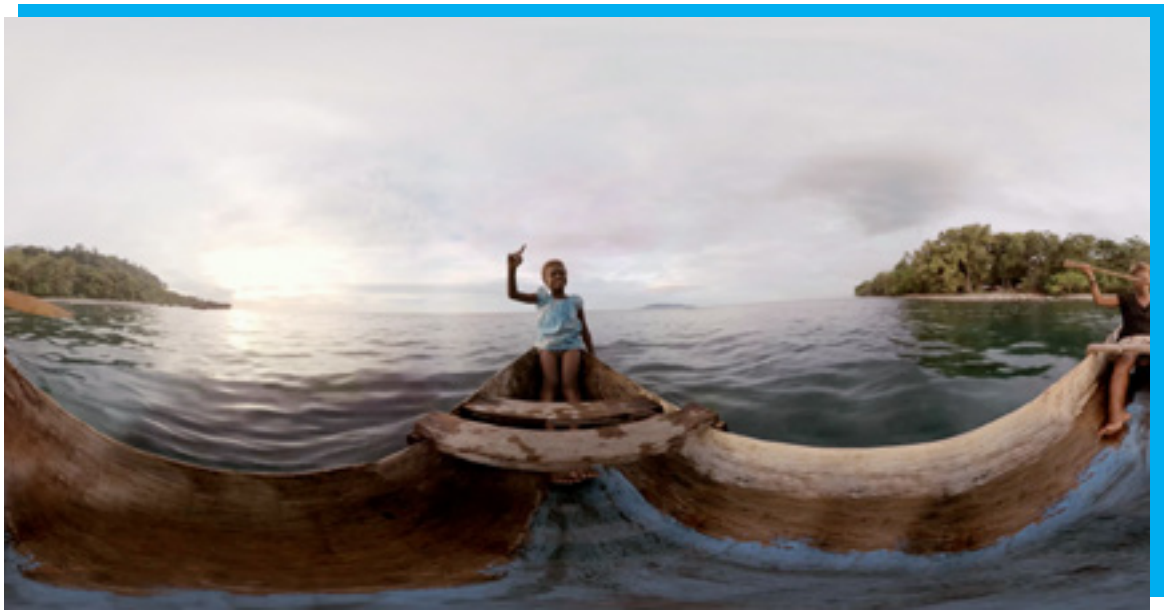
Ardalan at SecondMuse] References/Inspirations: Ruth Aylett, Janet Murray).
An excellent reference can be found in the research done by Katy Newton and Karin Soukup, audience experience designers in their work entitled:
The Storyteller's Guide for VR.



Behind the scenes filming The Price of Conflict, The Prospect of Peace: Bougainville Courtesy of Alana Holmberg

SecondMuse and the Australian Department of Foreign Affairs and Trade's innovationXchange traveled to the Southeast Asian island nation of Timor-Leste where they documented the work of food innovators in the cities of Dili and Baucau using 360˚/virtual reality storytelling. The film Eating With the Seasons was soft launched in Canberra, Australia on August 8, 2017.

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The distinctions within the current state of VR from the stage or live action storytelling are predominantly caused by technology and the nature of human sensory perception. Most VR systems to date (mid-2017) have little haptic response and distort the user's self-perception of body placement in space. As a result, the length and reach of their hands and feet, do not have the visual reassurance that connects to their kinesthetic sense of self-awareness. It is vital to overcoming the disorientation these factors cause; which will impact the user's comfort level and desire to stay engaged. Perception of time, as well, can be modified even more powerfully than in other media, due to the immersive nature of VR. And then there are the issues of VR Sickness, which we go into detail later in this document.

Beyond simply telling a narrative, to create a zeitgeist through a VR experience successfully, the designer or storyteller must create a compelling and safe environment.

Designers of the user experience in VR will have many more factors to consider. Now the entire environment is under the control of the design team, and the affordances may be complete familiarity (a pen writes like a pen) or foreign (a pen shoots rays that make objects come to the user's hand, magnetically).

User Interface for Virtual Reality

The concept of a User Interface for Virtual Reality can take on many forms. The important thing to keep in mind for VR is that the "interface" is the environment and any active affordance or interactive element in a virtual environment is the "interface."

User interfaces developed from the need to create an interactive visual communication layer between the machine and the user. The purpose of this is to make "code" easily accessible to anyone. User Interface designs of the past have been constrained by the need for display, and the input available for interaction was limited.

Virtual environments do not have these same constraints, so we should not limit ourselves by designing for them. Instead, there are other aspects to the "interactive visual communication layer" in VR that must be designed.

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To design successful UI for VR, you must consider not only the regular visual affordance that users have come to rely on for navigation (and possibly discard them) but additional sensory affordance. For example, motion and audio, as well as functional affordances.

The UI for VR could be something as familiar as an application menu presented as a heads up display (HUD). You could interact with this HUD in much the same way as you would a computer display menu; selecting items and triggering actions with a cursor. The input may even be a familiar controller. However, there is a world of possibility and necessity available to change these "interfaces" in virtual reality.

As a creator, you are not constrained by a surface display or one method for input. The level of interaction in VR must be considered when creating the "interface."

So, although it may be tempting to create a simple HUD for your VR experience, it is not the best solution for the user and can introduce new issues that make HUDs impractical or even uncomfortable. Try incorporating the navigational elements into the users' environments instead, making the "interface" intuitive to the actions and narrative.

On the next page are a few suggestions on designing the interactive elements ("user interfaces") for virtual environments. The numbering references are listed next to the comment so you can read more about the original source material listed below for proper citation.

A key to help understand the number system:

1) Functional
2) Visual
3) Auditory
4) Motion

6 Functional Interaction

Attempting to integrate information into the environment is ideal. For instance, rather than a mini map and compass in a HUD, the player might get their bearings by glancing down at an actual map and compass in their avatar's hands or cockpit. **(1)**

If the interaction is in response to an object, make it clear from the size and shape of the object how to start and stop the interaction.

Paint reticles directly onto targets rather than a fixed depth plane. **(1)**

Be sure to space out UI elements so that users don't accidentally trigger multiple elements. **(4)**

When possible, allow users to operate with a familiar controller that they can manipulate without sight. **(1)**

Limit the number of gestures that users are required to learn. Simplify. **(4)**

Visual Interaction

The cFOV (camera field of view) and the dFOV (display field of view) must match exactly. The ratio between these two values is referred to as the Scale, and the scale should always be exactly 1.0. **(1)**

Use 3D cinematic tricks, parallax, lighting, texture, and other visual cues to communicate, create and reinforce a sense of depth and space. **(3)**

The "physical" design of interactive elements in VR should afford particular uses. **(1)**

Don't neglect monocular depth cues, such as texture and lighting. **(1)(3)**

Avoid thin objects and ornate textures in places where users will focus their attention.**(1)**

Avoid visuals that upset the user's sense of stability in their environment. **(1)(3)**

Ensure that users can interact with objects occluded by their hands. **(4)**

Use visual feedback to encourage users to keep their hands within the tracking zone. **(4)**

Make the user's hand semi-transparent when near UI elements. **(4)**

Make objects large enough to be seen around the user's hand and fingers. **(4)**

Avoid placing objects too high in the scene, as this forces users to raise their hands up and block their view. **(4)**

When an interaction relies on a user moving in a certain way, or making a specific pose, create affordances to encourage this. **(3)**

6 Visual Interaction

The more specific the interaction, the more specific the affordance should appear. **(4)**

Include a means of resetting heading to the current direction of gaze. **(1)**

Interactive elements within a scene should typically rest between desk height and eye level.

Adjust the scale of avatar hands to match your game environment. Keep in mind that human hands naturally move in arcs, rather than straight lines. **(3)(4)**

Close-up objects and interactions can lead to eyestrain; when necessary, make them a part of the avatar that drops out of view when not in use. **(1)**

Aim for the recommended minimum comfortable distance of 75 cm. Objects rendered closer than 75 cm (within reach) may cause discomfort to some users due to the disparity between monocular lens focus and binocular aim. **(1)(3)**

Don't neglect monocular depth cues, such as texture and lighting. **(1)(3)**

Avoid thin objects and ornate textures in places where users will focus their attention.**(1)**

Avoid visuals that upset the user's sense of stability in their environment. **(1)(3)**

Heads Up Displays (HUD) Basics

Define the pixel size of the design canvas as 3600 × 1800—If you're using a equirectangular background (flattened projection of a 360-degree environment make sure your canvas proportions are 2:1, and 3600 × 1800 pixels. **(1)**

Isolate a 1200 × 600 pixel area of interest within the design canvas – (represents one ninth of the 360-degree environment) positioned right at the center of the equirectangular image. **(1)**

Place text and images on slightly curved concave surfaces. **(3)**

Menu items should be large and well-spaced enough for users to accurately target them. **(1)**

Limit the angular range of text to be close to the center of the user's field of view (e.g. making text appear on a surface only when a user is looking directly at the surface).

6 Auditory Interaction

Try to provide audio cues to indicate when an interaction is taking place.

Sound can also be used to direct the viewer's attention to tell the story.

Sound can also be very effective in communicating the success or failure of interactions. **(4)**

Motion Interaction

Avoid rotating or moving the horizon line or other large components of the user's environment if it conflicts with the user's real-world self-motion (or lack thereof). **(1)**

Displays should respond to the user's movements at all times, without exception including menus and during interactions. **(1)(3)**

Ground the scale and movement of avatars in the user's real-world self-motion (or lack thereof). No movement should take place unless it's user-driven. **(1)(4)**

If the intended interaction is a motion, make a clear indicator where the user can start and stop the motion.

Gesture operations can harness the power of hands for digital experiences by bridging the virtual and real worlds in a way that's easy for users to understand. **(3)**

Clearly describe all intended poses and where the user should gesture to complete that pose.

When describing gestures be sure to clearly an account for all characteristic and qualities of the intended interaction. Be as specific as possible to get the best results, as this will greatly impact how the user performs the interaction. **(4)**

Leveraging the sensors for control input (e.g., aiming with your head) can be an intuitive and user-friendly interaction method, as long as the user has a clear targeting cursor (rendered at the depth of the object it is targeting) but be careful of nauseating interactions between head movements and virtual motion. **(1)**

Consider offering a "tank mode" style of movement that users can toggle. **(1)**

6 Testing Considerations-before release of your experience

Test your content with a variety of un-biased users to ensure it is comfortable to a broader audience. Like anything else in this young medium, user testing and evaluation are necessary to see what works best for your experience. **(1)(3)**

When designing hand interactions, consider the user's perspective by looking at your hands with a VR headset. **(4)**

There are many good references below, with the uxofvr.com serving as a fine collection of learnings regarding the particular needs of users. Both for specific VR devices and general approaches to user experience design; moving from 2D and contained viewing technology (web/mobile/handheld/keyboard/mouse/touch-input) to VR and gesture-driven interfaces.

Eye tracking, non-hand gesture controls, voice control and haptics will become part of the user experience shortly. And will add further richness and other considerations at how to tell the story in a way that delights the desired audience/user.

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User Interface and Interaction Resources

(1) Functional

https://developer.oculus.com/design/latest/concepts/book-bp/

(2) Visual

https://www.smashingmagazine.com/2017/02/getting-started-with-vr-interface-design/

(3) Auditory

https://developer-archive.leapmotion.com/assets/Leap%20Motion%20VR%20Best%20Practices%20Guidelines.pdf

(4) Motion

https://medium.com/@LeapMotion/vr-design-best-practices-bb889c2dc70
http://www.uxofvr.com/
https://blog.kickpush.co/beyond-reality-first-steps-into-the-unknown-cbb19f039e51
http://www.xgmedia.com/designing-the-screenless-experience/
https://www.usertesting.com/blog/2016/04/15/invisible-ui/
https://unity3d.com/learn/tutorials/topics/virtual-reality/user-interfaces-vr
http://facebook.design/vr?ref=webdesignernews.com
https://medium.com/startup-grind/4-things-i-learned-designing-user-interfaces-for-vr-cc08cac9e7ec
https://www.youtube.com/watch?v=iR4iRyLoJlg
https://virtualrealitypop.com/designforroomscalevr-a41e646444e7
https://www.usertesting.com/blog/2016/04/15/invisible-ui/
https://vimeo.com/116101132
http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality
http://www.creativeblog.com/ux/the-user-experience-of-virtual-reality-31619635
https://uxdesign.cc/design-practices-in-virtual-reality-f900f5935826
http://uigarage.net/blog-post/how-to-design-for-virtual-reality/
http://www.dtelepathy.com/blog/design/the-ux-of-voice-the-invisible-interface
https://www.youtube.com/watch?v=NYoqUomgTGU
https://backchannel.com/immersive-design-76499204d5f6

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VR sickness has been marked by discomfort, headache, nausea, drowsiness, fatigue, and disorientation. It is similar to simulator sickness and motion sickness, but VR sickness is caused by a 'visually induced perception of self-motion,' not motion per se. Those more susceptible to motion sickness are found to be more susceptible to VR sickness. The upside? They've found that the more you experience VR, the more resistant you become to VR sickness.

We experience VR as if in real life, and real life doesn't have a lag. VR tricks the visual part of the brain into believing something that isn't real. When this happens beyond the brain's tolerance level you start to feel sick. According to Ryan Betts' article Practical VR Design Cheat Sheet (a recommended read) he suggests, 'a sampling rate of 100Hz minimum, 1000+Hz. And points out that poor performance on how many times per second positional and orientation data is sampled is one of the root causes of motion sickness.' When architecting a VR experience avoid lateral motion with large objects, and high speeds, avoid fast motion toward the user and be careful about moving the user. To help avoid this sudden onset of nausea, take breaks, chew some gum and try to follow the rules. And always, always put it on your face when testing.

Ref: https://virtualrealitypop.com/practical-vr-ce80427e8e9d

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Camera

We are in the tricky era of VR where the camera technology is developing quickly, and new cameras are being released almost faster than we can evaluate effectiveness. It's hard to buy a camera knowing the next evolution is coming to market soon.

A DJI Mavic Pro drone outfitted for 360° video capture with 3D printed mounts and Kodak SP360 4K cameras
Courtesy of Ben Kreimer for Making Waves

Here are variety of cameras that are available at LA VR rental houses.

Another source is Kitsplit.

These would be in addition to the established rental agencies like Abel Cine.

We recommend renting equipment if possible. And before we go any further it's important to consider the camera, lighting, and sound equally; in balancing the quality of production against the vision, you have of the content you are creating. Likewise, if a project looks like it will cover a good chunk of the camera cost, then maybe it's all good to invest in purchasing one.

It's also good to keep in mind most viewers aren't judging a VR experience based on the high resolution of an experience. The pieces that seem to be doing well are some combination of the new technology, but almost all have a point a view. Think about Youtube and Facebook videos. A lot of these aren't the best quality, but people watch them because they are entertaining, unusual or insightful. So first off, don't get caught up in the best camera out there. Aim to get a camera that you feel meets the needs of your purpose, story, budget and viewer requirements. Just start.

Lighting is just as important, if not more than the camera itself when it comes to visual quality. Make sure you take note of the lighting section. Immersive sound is really important too, so make sure you take these three elements into account along with the script/story you are telling.

Now let's get into the nitty gritty camera stuff. There are different outcomes from different cameras that you need to understand before diving into making VR. Some questions. Is your VR experience photorealistic or is it going to be CG or a mix? Will it be 'room-scale' where you can walk around and pick things up or is it more of a sit and look around?

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Different camera / capture tech to consider individually or together

Here are a list of the types of available cameras:

- Livestream option - more lo-fi or aimed at live events.
- 360 - Any camera here is reasonable at the moment just get one in your price range and technical level depending on how much stitching and painting you want to do. Remember when filming in 360 to make sure that the stitch lines don't fall over faces and don't fall over your main focus point.
- Stereoscopic 360 - gives object's depth - The Jaunt One, Nokia Ozo, Z-1 Pro are manufactured stereo configurations, that have a post production pipeline. Many filmmakers use Red Epics, Black Magik and GoPro cameras to create their own configuration.
- 6 degrees of movement cameras - where the viewer can move a little bit up and down left right forward and backwards e.g Facebook's new cam.
- Capturing photorealistic volume - 8i.com, DepthKit, Humense
- Photogrammetry - turning static real objects into photorealistic digital assets.

Here are some great references to cameras.

Here is a field guide for shooting VR.

The rest of the techniques are the traditional computer generated, motion capture type techniques which have been around the film and gaming industry for ages.

Lighting

Lighting a 360 set can be done in many ways. Natural interior lighting can be used any on set lighting has to be lamps, candles, or a camouflaged light. You can also use split screen techniques in post to add and remove lighting for more control. It is always best to have the camera operator familiar with the camera system and an experienced lighting professional.

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Manage exposure!

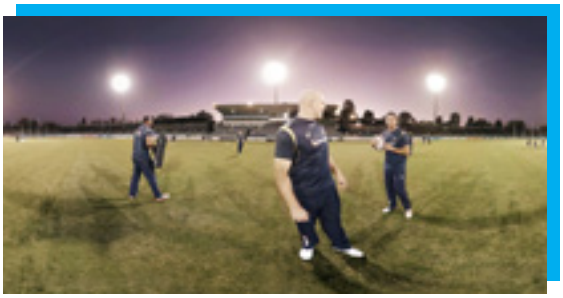
Virtual reality means that you are creating a new reality for who ever is experiencing your virtual reality experience. Therefore, whatever rules apply to that world you are creating should be adhered to in your experience. For example, if your experience is based in a living room in a world the same as ours, then light it as you would find a living room using practicals. But if your world is a futuristic sci-fi then go to town with LEDs. The trick is to try and balance light levels more than anything. The current cameras on the market don't have a huge amount of dynamic range, so anything too hot will probably blow out; e.g. fluorescence in the roof. You can fix this by just adding some diffusion. Under exposed material, will create camera noise and distract from the user experience.

Here are some examples and of the advantages and drawbacks of some of the higher end 360/VR camera systems.

LEDs in a range of sizes from mini-ferry lights to big LED tubes; can hide behind things and bounce light from. Remember if the camera can't see it you can use that space to place lighting if it's relevant.

Every 360 or camera has its strengths and weaknesses such as weight, portability, latitude, camera overlap, stereo or mono. Each project requires an in depth look at the script, location, lighting conditions, static, or moving camera, post pipeline and overall image quality. It is also good practice to do some test shoots at your local rental house especially before making a camera purchase and to look online at reviews. Camera video and image quality comparisons should be taken into account as well.

When capturing 360-degree video in the field, SecondMuse storytelling technologist Ben Kreimer, works with the Z CAM S1 and Kodak SP360 4K cameras. These cameras enable precarious camera placements, such as on motorcycles, drones, and off of vehicles. Kreimer highly recommends the $2500 Z CAM S1, as it's a very robust, portable, and easy to use camera that produces high-quality video equivalent to that of a six-GoPro rig.



S1T2 waited for just the right lighting in this scene of the HSBC Wallabies All Access VR experience to feature a beautiful, purple sky without post-production editing Courtesy of S1T2

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Underwater cameras and Drone 360

Shooting 360/VR underwater presents a unique set of challenges that can be overcome with adequate preparation.

Critically, make sure that the camera housings all contain anti-fog dry strips to prevent condensation from forming. Replace these strips when they take on any moisture These strips are easily purchased online, however note you'll have to bake them before going into the field.

It is also recommended to put Rain-X on the exterior of the housing dome ports so that droplets will quickly run off for shots where the camera emerges from the water or is outside in the rain. To stabilize underwater shots, a slim-profile, metal photography tripod works well. Simply set the tripod underwater, set the cameras and swim out of the shot. For moving shots, a long selfie-stick works well. Remember, always, to set the White Balance of the cameras to underwater mode, if the setting is available.

Finally, and especially if you are not SCUBA-diving and relying on snorkel/freediving, be extremely careful not to lose the camera.

The following is advice from Bret Garling, founder of Cut Canvas Creative and Director of Communications at Mission Blue. He says, if you set a tripod, then swim out of the shot, you may not be able to find it again. Going up and down to get air is disorienting. It is highly recommended to only set the cameras while using SCUBA, or while in shallow water that has high visibility.

Two years ago story technologist Ben Kreimer began working with drones to capture 360-degree video as the inaugural fellow at the BuzzFeed Open Lab in San Francisco. He says there are numerous ways to capture 360 video from a drone, most of which involve some degree of hacking together a kit. This could involve dangling a six GoPro rig underneath a large drone, like a DJI S1000 or DJI Inspire Pro, or using a platform as small as a DJI Mavic Pro with a Kodak SP360 4K camera on the top and bottom, which results in seamless 360 video with the drone completely removed from the shot. It's hiding out of sight between the two cameras.

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Kreimer has custom designed his own 3D-printable camera mounts for the Kodak cameras and the Mavic drone, and he gives the 3D object files to anyone who wants to print their own. Regardless of the platform used, it's a good idea to mount cameras on the top of your drone, or else the top of your video sphere will be the drone rather than the sky. (Ben Kreimer works with Davar Ardalan at SecondMuse)

Stitching

- Proper stitching pipeline is essential for every project and should be tested before embarking on any VR project.
- Stitching is now offered from http://www.bydeluxe.com/creative/virtual-reality and http://www.technicolor.com/en/solutions-services/entertainment-services/virtual-reality as well as many VFX houses around the world. There are automated workflows tailored to specific camera https://www.jauntvr.com/camera/ozo/ https://www.jauntvr.com/technology/
- As we as commercially available stitching software http://www.kolor.com/360-videos/http://www.video-stitch.com/

Editing

There are a few edit systems that can handle VR editing. After writing, and shooting, editorial is where the the final story comes together. It is the editor's job to pace the story and complement the director's vision. There are books written about creative editing for the story and just as many on the technical aspects.

- This is a good overall article that goes thru part of "The Process" and interview with editor Duncan Shepard putting together a 5 part Paul McCartney experience. http://www.fcp.co/final-cut-pro/articles/1845-final-cut-pro-x-and-pure-mccartney-vr-filling-out-the-viewscape
- Apple's Final Cut Pro X is a very capable VR editing package https://www.apple.com/final-cut-pro/what-is/
- Adobe Premiere http://www.roadtovr.com/adobe-brings-vr-video-editing-tools-to-premiere-pro-360-stereoscopic/

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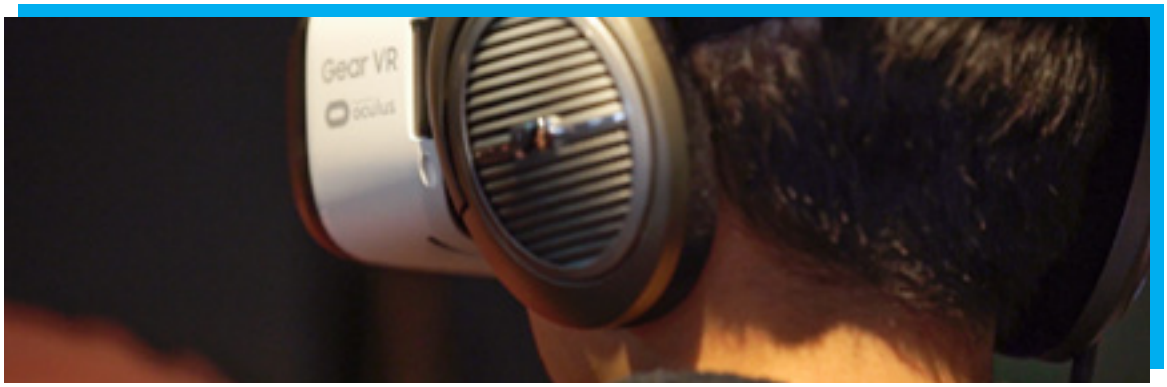
Ambisonic and Binaural ambient tracks can be extremely valuable in any VR project because they require a certain amount of time, commitment and concentration that isn't always available in the 'heat of the moment' when you're recording dialog and synch sound. Try to plan for time that's not dedicated to a camera shooting, ie before or after essential shooting windows, to record these critical atmospheric tracks. They can make the difference in creating credible, authentic and captivating soundscapes in post production (DH).

When filming wildlife/natural history, make sure the sound recordist is given time before /after the primary shoot to capture atmospheric tracks. Same goes for urban environments.

When capturing spatial audio while working in the field, storytelling technologist Ben Kreimer, uses the Tetramic ambisonic mic hooked up to a Zoom H6, or for fast moving shoots he uses the Zoom H2n audio microphone and recorder mounted on the tripod or light stand of his 360-degree camera rig. It's the same audio recorder used with the 16-camera Google Jump 360-degree camera rig.The H2n is a $160 recorder that can output ambisonic spatial audio recordings. When positioned under or over the camera, the spatial audio recordings can be synced up and aligned with the 360 video for immersive audio playback. In addition to recording spatial audio, stereo and mono audio can also be used in a spatial audio mix, by positioning the sounds in the 3D soundfield. One way of executing this with a person speaking on camera would be to record ambisonic audio at the location of the camera while having the individual mic'd up with a lavalier mic. In post-production, the ambisonic sound field recording can then be mixed together with the more pristine lavalier recording, which would be positioned appropriately in the 3D soundfield.



A truly immersive VR environment requires both great graphics and convincing sound Courtesy of S1T2

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I don't mean to be flip - but watch Citizen Kane. Depth in 360/VR is like depth in other forms (to me); the difference is that in 360/VR you can generate depth 3 ways, not 2: method 1: create a deep space shot. Method 2: cut from a flat or shallow space shot to something with depth - which accentuates the depth of the incoming shot. Method 3: create a 360 frame that has deep and shallow planes. Then motivate the viewer (probably with foreground action) to turn from the flat space to the deep space. Essentially their eye movement plays the role of the cut and the scene transitions to deep space.

Example - we tried to use all three designs in the VR film I recently field/story produced: 'The Protectors'

Rendering

- Because of limitations & variety in VR hardware, it's important to test and optimize the rendering and playback of your VR experience throughout the development process.

- Whether you're developing for mobile or PC based headsets, it's recommended you keep each scene between 60-90 fps. The Sony Play Station and some new Apple products support 120fps.

- For this example we'll be focusing on real time VR for Unreal Engine (UE4) rather than pre-rendered 360 content. However, the same concepts can apply to animated 360 content or the Unity engine.

- Try placing objects, lights, particles, etc in one area then monitoring your FPS when a camera is pointed towards it. This can give very good insight on performance for your scene.

Sequencer

Sequencer is Unreal Engine's built in movie making software. It essentially acts like a real time renderer and video editor inside the engine. Allowing you to build your

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scene, add animations, effects, sounds, and effects that play out in real time. It also has built in VR support, essentially making it a "plug and play" solution for animated VR filmmaking.

Post Processing

Post processing functions like color grading, bloom effects, camera grain, lens flares. It is suggested you view your projects on many devices. Over time you will be able to trust your monitor.

Baked Lighting vs Dynamic Lighting

A baked light is a light that is nonmoving and "baked" into your scene. Meaning once you place it, it will not update with realtime shadows or moving ambient light. This is much cheaper on rendering but obviously, has downsides. These are mostly used for backgrounds or large objects that have little to no movement.

Dynamic lighting is basically the opposite of a baked light. This allows for mobile lights that update the world around you and can cast realtime shadows on your characters and props. Much more expensive to render but can look more realistic.

Examples

Sequencer Rendering
http://studiodisrupt.tv/wp-content/uploads/2016/07/ss2016-07-05at12.53.44.jpg
https://www.youtube.com/watch?v=_wKOTmcHI84

Baked Lighting
https://www.youtube.com/watch?v=EWmyPdeYOiQ

Post Processing
https://www.youtube.com/watch?v=i9bnPStLYfk

Latest Developments on VR work:
OTOY's Jules Urbach explains the volumetric video technology developed in partnership with Facebook show how quickly things can evolve.
https://www.youtube.com/watch?v=EK3RaU6IPf4&

SUMMARY

The VR and AR industries are some of the fastest evolving and most active as far as venture capital investments and progressive technology at the moment. One short document can not fully summarize the industry. We believe, it will prove to eventually be life changing technology; especially when it comes to wearable technology, Head Mounted Displays and the impact on all aspects of our daily lives. This is an amazing time to watch as major corporations and consumers adopt and grow with this technology.