ALTUIT
ENHANCED REALITY

Product Design using Virtual Reality

Whitepaper

Introduction

A powerful shift is underway in the tectonics of the design industry. Design processes are being disrupted. The change brought on by this disruption is nothing short of astonishing.

Not since the digital renaissance of the 80's have we seen emergent technology which impacts all phases of design.

Just as designers in the past who did not adjust to the new digital paradigm, today's designers who fail to anticipate the current shift risk being discarded on (or abandoned at) the wrong end of the learning curve.

Designers now immerse themselves inside new, non-real environments. They see, hear, and experience a radical, new perspective on design. This new perspective is known as: Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). These technologies mark the high side of today's learning curve, and the pathway to the future.

Investors are funding new VR/AR/MR startups with the same vigor and enthusiasm as they did when the Internet and world wide web were the the hot prospects of their day.

Before considering the specifics of this emerging opportunity, it's important to review a few basics that define spatially based media.

What is Virtual Reality (VR)?

"Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment."[1]

VR uses a headset and technology to create the perception that a person is in a completely different space. It does this by creating two stereographic images, one for each eye, which fools the brain into seeing a 3D image. The technology also tracks the head and optionally the body movement so as to render the view in a matching and expected perspective. This has the effect of the user perceiving they are in fact inside a real environment.

[1] WhatIs.com: DEFINITION virtual reality
http://whatis.techtarget.com/definition/virtual-reality

Common hardware implementations include *Samsung*, *Oculus Rift* and *HTC Vive* with room-scale.

What is Room-Scale?

"Room-scale" describes a VR experience within a physical space with otherwise invisible boundaries.

This configuration allows a user to experience the VR space within a real world scale. They can navigate around objects, inspecting them from every angle. As the headset nears the physical room boundary, a white grid appears, telling the user to go no further, thus protecting them from bumping into objects and walls.

With room-scale, VR users can lay down in a virtual tent in the middle of a forest, or sit at a table in an industrial kitchen (assuming there is a real chair or stool underneath them).

What is VR presence?

"Presence" is a term coined to convey the feeling, one is "actually there" in a VR space. This technical illusion is conjured by realistic lighting, textures, materials, room-scale, and scenario.

What is Augmented Reality (AR) or Mixed Reality (MR)?

"'Augmented reality (AR) is the integration of digital information with live video or the user's environment in real time."[2]

AR/MR can take many forms, from a smartphone mapping computer generated images onto a camera scene, aka *Pokémon Go*, to a maximized technical implementation based on advanced headset and/or glasses architecture. The more technically advanced systems deal in what has been called, "Mixed Reality", and share many capabilities with VR such as head tracking and room-scale positioning. Examples of MR devices include *Microsoft HoloLens* and *Magic Leap glasses*.

What are the prevalent Software VR playback systems for VR?

Currently, most VR developers use one of two systems: *Unreal Engine 4* and *Unity 5.* Both are highly optimized and robust game development platforms. Amazon has recently

[2] WhatIs.com: DEFINITION augmented reality (AR)
http://whatis.techtarget.com/definition/augmented-reality-AR

jumped into the VR developer fray, licensing a game engine (*CryTek CryEngine*). They call this new gaming technology: *Amazon Lumberyard*.

Game engines are uniquely adept at handling VR. First, they're optimized for smooth, real-time video. Game engine developers have spent years working with graphics vendors like *Nvidia,* deploying massively parallel graphics computing engines for use with sub $1000 video cards. These cards are highly optimized, and generate photoreal renders in a fraction of the time required by a non-optimized cpu. Vendors for game engines serve vibrant user-communities, large assets stores, and complete VR toolsets. The best part is: they're readily accessible and free for use in VR simulations.

The challenge for all who work with these systems is to create an efficient workflow. One that enables designers to move quickly through the developmental pipeline, and iterate (revise) their final product .

What is a VR Pipeline?

The concept of a workflow-pipeline originated in the early multimedia, game and special effects industries. The concept was simple. There were so many programs and steps needed for the creation of highly specified content, project development needed a game plan.

Hundreds of thousands of dollars were often at risk. A simple rendering misstep could easily force a complete restart of a project. The solution involved the establishment of a procedural formula that came to be known as the "pipeline." A significant management component in the pipeline involved the setting of milestone-review points . Based on these assessments, the project proceeded with a degree of certainty from milestone to milestone. Unfortunately, this lengthy developmental pathway did not allow for easy "do overs," or iterations.

The goal of a VR Pipeline is to make it as easy as possible to iterate (or revise) the final product. This is done by limiting critical review points and matching collections of software that employ automated processes.

Until recently, there was little --if any --emphasis on an iterative VR Pipeline for designers. Pursuit and implementation of this management tool has been a goal of the work being done by *Altuit*.

Iteration and Design

First-year design students discover a cornerstone of the design process is to continuously iterate a design until they reach the appropriate refinement. Iterative freedom is one of the building blocks for multiple development methodologies, and is key to both successful design and customer experience. This is what the Agile development process is all about.

Designing products using VR is significantly different from creating a VR game or interactive media experience. For effective design, the pipeline and formula must be as concise as possible, allowing for quick iterations and turnaround revisions .

Unfortunately, game and interactive media design make no allowance for extreme iteration. Their pipelines involve multiple steps with many different specialists involved in each step.

This is one reason why traditional VR gaming processes fall short of serving non-gaming products and their user pipelines.

A key difference between the two approaches involves how the assets are organized. Game-oriented objects are custom built and optimized using low poly quad-based meshes. Another difference involves the level of attention game-developers dedicate to UV and light maps.

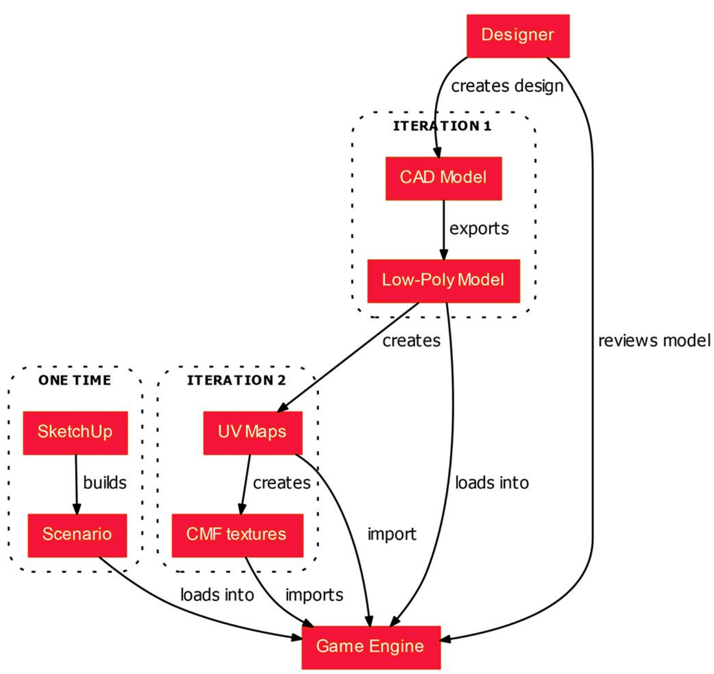
Product designers typically create their designs in CAD solid modelers using NURBS, which don't usually export optimized meshes for VR. To make matters worse, few -- if any -- mainstream CAD packages have the capability to create UV maps for exported geometry.

It is vital to take these issues into account when building an efficient VR pipeline for a non-game product and its attending customer requirements.

What is Product Design using Virtual Reality (PDVR)?

PDVR describes the application of Virtual Reality (VR) techniques to Product Design, Human Factors, and Customer User Experience. It's a shortcut term for using VR to help create better designs. PDVR focuses on rapid, room-scale prototyping for maximum VR presence. At the heart of this approach is an emphasis on rapid iteration of design and timely review of milestones as the final product evolves (emerges)..

A Simplified Diagram of the PDVR Pipeline



Basic components of PDVR

Scenarios are built once, then repeatedly used.

Two iterative workflows are typically required.

1. Form (geometry)
2. Materials (textures and colors)

The goal it to limit the amount of time needed to modify both workflows.

Example 1

For instance, in designing a product like a popular brand tent using a PDVR process, the designer will better comprehend the interior space by sitting inside a VR rendering of the tent. Walking through the VR door aids in anticipating the ergonomic issues of access. Similarly, looking through a VR-created screen window provides the designer with a critical perspective on line-of-sight.

Grabbing a nearby cooler and rearranging the tent contents are frequent tasks which can also be easily understood in room-scale VR. The designer might even hang a lantern in the tent to identify possible areas that are too dark, or in shadow.

When a modification is needed, the PDVR pipeline anticipates a quick edit to the CAD program, after which, the designer can visualize, once again, the revised VR-tent model in the middle of a VR forest.

Example 2

Another interesting example of Product Design is found in the design of a branded retail store. The designer generates the store design using CAD, then quickly proceeds to walk through the store in VR. The same access is available to Subject Matter Experts (SMEs), stakeholders, and end users. In most cases, feedback can be generated in real-time, as well as the reiterated design that results from the feedback. Key Goals

There are 6 key goals for PDVR.

1. Create a streamlined, simple development pipeline so designers can prototype without having to learn programming, or become an “expert VR designer.”
2. Focus on prototyping speed so that fast and iterative design ideation can take place in VR.
3. Create photorealistic models to enhance “VR presence, instead of (as opposed to) creation of VR “game assets,” which appear primitive and diminish believability . In addition to creation of high quality VR assets, the PDVR approach takes into account rendering efficiency with a special focus on the frame-rates needed to simulate presence.
4. Generate scenarios so products can be seen in appropriate environments and context.
5. Build “room-scale” models to identify scale, ergonomics and usability issues quickly, and early in the process.
6. Save money by saving time. Time in both the early mock-up stages, as well as more advanced user testing and prototyping. PDVR also helps designers create fewer real world prototypes, saving valuable budget resources while streamlining the go-to-market timeframes.

Other advantages

Though not a specified goal, PDVR assists sales and marketing in an early understanding of the product, even lending to demo support at trade shows. Whether enhancing product sales at trade shows, or other marketing venues, PDVR gets people excited about “being there.”

Additionally, executives use it to help sell board members on new initiatives, while support personnel are provided early feedback on serviceability, as well as maintenance training during the various phases of deployment.

Why are people interested in PDVR?

Within the next couple years, design management will be bombarded with multiple sales, marketing and promotional channels all wanting to put their particular brand of VR in their hands. Now is the time to get ahead of the rush and learn about VR, the vernacular and available products as well as the process and workflows necessary. Just as when CAD first arrived on the scene, early adopters will have a decided competitive advantage over competition.

Why VR and not AR/MR?

It’s a great question, and the answer has to do with the distinction between leading edge and bleeding edge.

Currently, the state of the art is easily accessible with hardware and software in the VR industry. Not true for MR, and the state of the art in AR is still largely confined to smartphones.

Remember: the goal is a highly optimized pipeline, one which designers can iterate quickly. Currently, this pipeline is only possible using VR.

At some point within the next few years, MR is predicted to catch up, then even pass VR in concepts like presence and room-scale.

How is it done?

The Design Pipeline

The typical product design methodology involves some or all of the following:

- definition of the product
- discovery of workflows
- interviews with end-users and SMEs
- sketches
- rough scale mockups
- CAD modeling
- rendering
- and finally a visual prototype.

Prototypes are typically created by talented, model makers or 3D print services. Some companies do their own 3D printing, and many have assigned one or two individuals to manage it.

From a design perspective, tremendous skill and experience are needed to “get it right” on the first prototype. A VR approach to early prototyping saves time and hard model cycles.

Let's look closely how PDVR can help the designer.

Define phase

During the initial definition phase, design visualizations, vision videos, blue sky concepts, and 3D rendered scenarios were created to sell or kickstart a new program or project.

A PDVR project empowers project team leaders in the sharing of their vision, while providing a cost effective proof-of-concept. When a person steps inside a room-scale VR project for the first time, the experience is breathtaking, and bound to shed a light on the project as a whole.

Discovery phase

Workflows, ergonomics, component configurations are all great candidates for a VR experience.

Imagine how a product is used in a specific kitchen. How valuable is it to have basic scale models inside a fully detailed kitchen space where users can pick them up and interact with them while you record their actions on video?

Many of these VR scenarios can be built and deployed in a single day, sometimes even an afternoon. What previously took weeks of real world setup, purchasing, and planning can now be accomplished in hours.

A well known container manufacturer can test a new food cart workflow in an industrial kitchen one day, then examine their new baby stroller design within the same virtual space on the following day.

SME, stakeholder and customer input can be virtual, iterative and often. You can also move and arrange large pieces, like walls and room components with ease using PDVR.

Design phase

Early volumetric studies are easily better understood in room-scale VR, and developed more quickly than corresponding efforts such as the creation of multiple foam core mock-ups. Working out details on a CAD screen removes the designer from a real work scale and context component.

Viewing a drone model in VR changes one's understanding of appropriate detail scale, allows for the examination of reflections and affords a preview of surface continuity issues.

Most VR systems use Physically Based Shaders (PBS) to render materials in scenes.

While PBS can depict superior accuracy in many CMF (Colors, Materials and Finish), it can be somewhat limited for VR. It certainly helps with scale and color issues. Finishes like brushed and anodised metals, chrome, stainless steel, fabrics, plastics, wood, concrete, rubber and many others are most accurately represented.

But some, like glass, clear or translucent plastics, crystals and gems, and subsurface scattering materials like skin and wax can be more difficult to get photorealistic results.

Another interesting by-product of the PDVR process is the ability to create photoreal 2D images and more importantly hi def videos in real-time. These are easily shared and come in quite handy when a VR system is not available.

Starting your own VR Design Lab

The actual software and hardware tools required for all this is actually quite inexpensive. Much of it is free. There are no proprietary tools required other than off the shelf software.

It's important to understand this is an evolving process, and the tools and techniques will change as will the challenges of creating newer and increasingly efficient workflows.

A fully implemented hardware configuration, including VR equipment and computer is far less expensive than might be expected.

Altuit also provides a number of free *YouTube* videos which can help in understanding some of the basic workflows.

About Altuit

Altuit is a design consultancy focused on helping corporations create Product Designs using Altuit's own 5Ds process (please see Altuit 5Ds Whitepaper). We have worked with hundreds of clients over the years to help them design hardware, software and create visions for the future.

Altuit has recently been asked to help build the VR labs for Newell Brands, as well as design and create a VR walkthrough for the Hunan Design & Innovation Center in Changsha, China.

Altuit Design and Altuit ER are divisions of Altuit, Inc.

Altuit helps companies develop their own PDVR Labs

For those interested in learning more on how they can build their own VR labs, Altuit has a basic workshop which helps technically adept designers. The workshop covers:

1. How to setup, install and configure the hardware and software.
2. How to optimally export models from CAD to VR
3. How to texture models to faithfully represent the chosen CMF.
4. How to quickly create scenes for use in staging models and scenarios.

5. How to use a VR engine to setup and configure scenes, light them, and view then in VR.
6. How to create a handheld transporter beam to move around scenes larger than room-scale.
7. How to setup a scene to be able to grab and move objects around inside it.

If you're interested in learning more about PDVR, please contact Ron Wood at *Altuit*.

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