VIMM

Thematic Area 2: Directions

Working Group 2.1: Technologies and Tools

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Abstract

The Working Group 2.1 Technologies and Tools of the VIMM Thematic Area 2-Directions has provided the outcome of work: a vast list of 89 best practices and state of the art examples of design (14), user experience (15), tools (14), user interaction (15), and technologies (31) in order to create an overview of available tools and technologies surrounding VR/AR that are, can be, or should be used by CH and to create an overview of tools and technologies that are required by CH to create VR/AR/MR. It included an analysis of some bad practices and examples too.

Introduction

The world of virtual reality (VR), augmented reality (AR), and mixed reality (MR) is growing at a seemingly exponential pace. Just a few key examples: Microsoft partnered with Asus and HP to release new MR headsets, Google glasses have made a comeback, Facebook Spaces launched, and a patent for AR glasses, filed by Apple in 2015, was just discovered during a patent search.

It can be confusing to know where to start as you begin developing in this field, because the three types of experiences (VR, AR and MR) seem to overlap at times, making it difficult to understand the similarities and differences. Each experience requires a slightly different development stack and tools, and in some cases necessitates targeting the specific display the observer is using. For example, VR that's created for a tethered headset means you need to create a virtual world for the user so the user is completely immersed in the scene.

The need to determine which tool to use for AR and VR is something many developers new to AR, VR, and MR are not aware of. Let's take a look at the steps for picking the right tool for the different reality types. Developers need to determine which type of reality they want to target and which types of users before they begin development.

VR and AR experiences sometimes require different tools and development environments, depending on what you want to do. For instance, if you want to develop a virtual reality game using Unity, you will need to specify the targeted headset (HTC Vive, Oculus Rift, PlayStation VR, etc.). If you want to develop an augmented reality application, you can choose to develop on a cross-platform toolset (like ReactVR), or you will need to target iOS or target Android devices. If you want to develop for the HoloLens, you can start with Unity and build for the HoloLens, and then you will need to use Visual Studio to test and deploy the application.

User adoption of the different experiences has not reached the critical mass needed to force hardware and software industries to standardize tools, interfaces, or programming languages. Until then, there is an opening in the market for innovative companies to step in and create a standardized toolset. For now though, developers still have to determine the type of reality they want to create, target the type of headset and platform, and then learn that set of requirements.

WG2.1 had the following scope and objectives:

to create an overview of available tools and technologies surrounding VR/AR that are, can or should be used by CH.

to create an overview of tools and technologies that are required by CH to create VR/AR/MR.

To achieve this, the representing experts created and assessed (items on) a list concerning five topics:

- **design** (interaction design, graphic design)
- **user experience**
- **tools** (heritage tools that give access to VR/AR)
- **user interaction** (social media, community building, gamification, citizen science, etc.)
- **technologies** (software programming languages, hardware, etc.)

For all topics, several Skype calls were organised and held, where experts presented best practices and/or state of the art examples. During the meeting, the examples were analysed and discussed by the WG members to establish what are pros or cons to use the specific methods/tools/products.

Design; graphic and interaction (14 cases)

According to Interaction Design Foundation, interaction design is an important component within the giant umbrella of user experience (UX) design.

https://www.interaction-design.org/literature/article/what-is-interaction-design

Interaction design can be understood in simple (but not *simplified*) terms: it is the design of the interaction between users and products. Most often when people talk about interaction design, the products tend to be software products like apps or websites. The goal of interaction design is to create products that enable the user to achieve their objective(s) in the best way possible.

If this definition sounds broad, that's because the field is rather broad: the interaction between a user and a product often involves elements like aesthetics, motion, sound, space, and many more. And of course, each of these elements can involve even more specialised fields, like sound design for the crafting of sounds used in user interactions.

As you might already realise, there's a huge overlap between interaction design and UX design. After all, UX design is about shaping the experience of using a product, and most part of that experience involves some *interaction* between the user and the product. But UX design is more than interaction design: it also involves user research (finding out who the users are in the first place), creating user personas (why, and under what conditions, would they use the product), performing user testing and usability testing, etc.

The **5 dimensions of interaction design** is a useful model to understand what interaction design involves. Gillian Crampton Smith, an interaction design academic, first introduced the concept of four dimensions of an interaction design language, to which Kevin Silver, senior interaction designer at IDEXX Laboratories, added the fifth.

Words—especially those used in interactions, like button labels—should be meaningful and simple to understand. They should communicate information to users, but not too much information to overwhelm the user.

Visual representations concerns graphical elements like images, typography and icons that users interact with. These usually supplement the words used to communicate information to users.

Through what **physical objects or space** do users interact with the product? A laptop, with a mouse or touchpad? Or a smartphone, with the user's fingers? And within what kind of physical space does the user do so? For instance, is the user standing in a crowded train while using the app on a smartphone, or sitting on a desk in the office surfing the website? These all affect the interaction between the user and the product.

Time mostly refers to media that changes with time (animation, videos, sounds). Motion and sounds play a crucial role in giving visual and audio feedback to users' interactions. Also of concern is the amount of time a user spends interacting with the product: can users track their progress, or resume their interaction some time later?

Behaviour includes the mechanism of a product: how do users perform actions on the website? How do users operate the product? In other words, it's how the previous dimensions define the

interactions of a product. It also includes the reactions—for instance emotional responses or feedback—of users and the product.

Why to employ an interaction designer? If the company is large enough and has huge resources, it might have separate jobs for [UX designers](#) and interaction designers. In a large design team, there might be a UX researcher, an information architect, an interaction designer, and a visual designer, for instance. But for smaller companies and teams, most of the UX design job might be done by 1-2 people, who might or might not have the title of "Interaction Designer". In any case, here are some of the tasks interaction designers handle in their daily work:

Design strategy

This is concerned with what the goal(s) of a user are, and in turn what interactions are necessary to achieve these goals. Depending on the company, interaction designers might have to conduct user research to find out what the goals of the users are before creating a strategy that translates that into interactions.

Wireframes and prototypes

This again depends on the job description of the company, but most interaction designers are tasked to create wireframes that lay out the interactions in the product. Sometimes, interaction designers might also create interactive prototypes and/or high-fidelity prototypes that look exactly like the actual app or website.

Diving deeper into interaction design

If you're interested to find out more about interaction design, you can read [Interaction Design – brief intro](#) by Jonas Lowgren, which is part of our [Encyclopedia of Human-Computer Interaction](#). It provides an authoritative introduction to the field, as well as other references where you can learn more.

References & Where to Learn More

5 dimensions of interaction design - http://www.uxmatters.com/mt/archives/2007/07/what-puts-the-design-in-interaction-design.php

Questions to consider when designing for interaction - http://www.usability.gov/what-and-why/interaction-design.html

1. Sensitive City

Was specifically requested for the Italian Pavilion at the Universal Exposition in Shanghai which took place in 2010. The idea follows in the wake of the great tradition of imagined cities, from Tommaso Campanella's City of the Sun to Italo Calvino's Invisible Cities. The holographic walls and the real-size story bearers as well as the natural interaction mechanics and the expert use of sounds are aimed at relocating visitors in a space other than that of the exhibition, namely small Italian cities, and to make them feel surrounded by "real people". Sensitive City employs ICT to create a highly immersive space able to relocate visitors in other cities and to make them interact with their citizens. Human body digital interaction uses 11 video-projectors, 2 Mac Pro, 7 Mac Mini, 4 Holopro screen, 6 scenery flat, interactive system using IR camera.

2. ART lens App – Cleveland Art Museum

One of the first to have a very clean graphic design, flat design, speaking directly about the kind of design we want to have in our app. It employs AR in very clear way – in this case the design is clean, interaction is very smooth and clean. The new ArtLens App is a completely re-engineered version of the Cleveland Museum of Art's award-winning collection application. Listening to user feedback, CMA ensured that the new ArtLens has enhanced its usability during last years. ArtLens is now faster and more user friendly, and the app download time has been reduced to 30 seconds. Improved optimizations have decreased the size of the app making ArtLens comparable in size to popular social media apps like Snapchat.

The redesigned interface is clean and intuitive and the way-finding map is more responsive, using iBeacons throughout the museum and outside to improve accuracy and eliminate the need for paper maps. ArtLens uses Bluetooth to connect to the museums iconic ArtLens Wall rather than RFIDs, making synchronization seamless. Improvements to the maps and new descriptions of each gallery make finding the information or artwork easier for visitors. ArtLens may be used on-site or from anywhere in the world.

A collaborative creation, ArtLens combines the most current technology and innovative design with a wealth of interpretive content provided by the museum's curatorial and interpretation teams. ArtLens includes a high-definition image and object information about every artwork on display in the museum and is updated in real time, ensuring that users have access to the most accurate information available. ArtLens enhances the visitor's museum experience by providing the option to design individual tours, offering tools to better understand artwork through augmented reality, and guiding users with interactive real-time maps.

The landing page of the ArtLens App is separated into four main categories:

Galleries: In the "Galleries" section of the app visitors can see updated maps, content, way-finding and nearby objects. Galleries are colour-coded and grouped thematically to facilitate easier navigation. Tap any gallery number to see what type of art is on display in that location or find gallery descriptions by tapping the gallery name.

Tours: Select from both museum-curated and visitor-created tours. The mapping feature locates specific artworks and navigates the entire tour. Choose to create a personalized tour that may be added to "visitor-created tours" and shared with the world.

You: Favourite artworks by tapping the heart icon on the ArtLens Wall or on individual artworks in the ArtLens App. All favourites are saved under "You." Favourites can be used to create personalized tours, find specific artworks in the museum or share on social media. Artworks learned about in the ArtLens Exhibition are automatically saved under "You" if a device is docked.

Museum: Get a daily snapshot of events and special exhibitions occurring at the museum as well as the location of restrooms, restaurants and exits. Museum hours of operation are also listed on this page.

3. EHC App – England's historic cities

http://www.heritagecities.com/stories/

https://www.youtube.com/watch?v=8LhJeE6rMzI

https://www.youtube.com/watch?v=WPOLrvQFEsc

https://www.youtube.com/watch?v=hZL-29p_0U8

Explore England's most prestigious heritage sites and uncover the human stories that make them so special. From towering cathedrals to ancient libraries, the England's Historic Cities app will take you on an epic journey into the past.

The England's Historic Cities app tells the stories of the country's best-loved heritage sites. Using innovative new mobile technology, visitors can gain new insights into the history of our twelve historic locations.

Find our trigger points scattered throughout each heritage site. Then, using your phone camera, uncover augmented-reality displays, 3D reconstructions, and 360-degree panoramas that tell the unique stories associated with them.

Hear stories told by famous historical figures such as William Shakespeare, Countess Ela of Salisbury, Bede the Venerable, and the Seventh Viscount Fitzwilliam of Merrion. Uncover tales of political intrigue, archaeological discovery, scientific innovation, and grand adventure no longer lost to time.

Chosen not because it is so innovative, but from a graphic point of view it uses absolute realism, cartoon like approach that in the end is very interesting.

They show in short films how the VR of the Apps look which makes it interesting and exciting. One wants to go there and try it out. Use your phone camera to activate an immersive augmented-reality experience that will unveil the hidden facts and stories that have helped to shape England's intricate heritage.

Discover the key to a whole new world with:

- Immersive 3D environments
- Stylized parallax illustrations of historical scenes

- 360-degree panoramas of secret 'zero-access' locations

- Augmented reality information boards

- Before-and-after sliders showing the power of time

- Application proposes a novel (cartoon-like) graphic approach to AR/VR apps for museums.

- Meet William Shakespeare, the Venerable Bede, Sir Joseph Banks, and a cast of colorful figures ready to take you on a journey through the annals of history. Along the way, you'll discover some of England's tallest tales, horrifying histories, magical myths, and larger-than-life legends.

- Hear the story of the giant who could lift 12 men at the Fitzwilliam Museum

- Walk in the footsteps of Roman Gladiators at Chester's Amphitheatre

- Discover the dark history of British justice and the tale of the Pendle Witches at Lancaster Castle

- Unearth slavery, ancient trolling, and the history of tea at Bath's historic Spa

- Explore the story of Shakespeare's entrepreneurial talents at Stratford-upon-Avon's new place

4. Skin & Bones App – Smithsonian national museum of natural history
http://naturalhistory.si.edu/exhibits/bone-hall/

Few museum exhibits in the world can claim to have survived across three centuries or have been gazed upon by tens of millions of visitors. The Bone Hall is one of them, a grand comparative anatomy exhibit that opened the Smithsonian's first museum in 1881. The design of today's Bone Hall still mirrors the selection and variety of skeletons used in the original exhibit - many of the prized specimens such as the great apes and swordfish are the same specimens that were on display. The exhibit highlights the diversity and unity of every major group of vertebrates, supporting ideas of evolution and common ancestry. It is one of the best study collections found in any museum.

Now through the latest mobile technologies visitors can enjoy a completely different experience while they walks through this celebrated, classic hall. Visitors can watch a vampire bat skeleton pull itself off the mount and run away, or an extinct Steller's Sea Cow materialize in the flesh.

These are only two of a number of 3D digital experiences available when using the app in the exhibit. It superimposes a virtual world onto the physical one. Visitors can also test their natural history skills playing games. There are many high quality videos to transport inquisitive minds to the environments of the animals, explain ideas in ecology, biogeography and evolution, or introduce scientists who work at the Smithsonian.

Augmented Reality and it superimposes a virtual world onto the physical one. - 10 augmented reality experiences with 3-D tracking will change the way you see skeletons

Two games and two interactives boost your animal skills. Selected because it tracks with great precision hi-quality 3D models on museum assets.

5. Browsing 3D artefacts from the Victoria & Albert Museum
http://www.3d-coform.eu/x3dom/index.html

Victoria & Albert Museum is also a good example; simple, but good. Presentation of fragile objects in 3D. V&A Museum London is promoting the reproduction, storage and sharing of works of art and cultural heritage through digital technologies. The idea to rewrite the Henry Cole's 1867 Convention in the context of the 21st century was initially suggested as part of their exhibition's, A World of Fragile Parts, at last year's Venice Architectural Biennale.

3D scanners have become increasingly powerful, allowing for the recording of entire buildings at impressive resolutions. Organizations such as the Zamani Project are using this technology to record much of Africa's built cultural heritage, which has been relatively overlooked by older cultural institutions and museums who have focused primarily on Europe. In this sense, new technology is not just allowing for a new way to preserve heritage, but also helping to redefine the canon.

Other organizations are exploring how 3D scanning can be crowd-sourced, solving the immense logistical issue of scanning vast amounts of data across the globe. The Institute for Digital Archaeology, for instance, has embarked on its Million Image Database. By distributing 3D cameras to volunteers around the world, they hope to build up a vast collection of digital models of important heritage sites. It's also now possible to reconstruct 3D models of lost artefacts through 2D records.

The technology of 3D Imaging is still very new, and as such its application, and real benefit to museums is still being properly established. As a result, many people have a number of questions and concerns about the use of 3D imaging in museums. However, it is worth remembering that many people had similar concerns when technologies such as plaster casting, electrotyping, and photography began to gain popularity during the 19th century, and when the V&A and others began building up their collections of copies from across the world. For these mediums, the fear has gradually abated over the years, as people have come to appreciate the value of copying for democratising the art world and enabling the mass circulation of imagery, design, and art history to a wide ranging audience. Like traditional methods of copying, 3D Imaging does not de-value the original or replace it, but rather offers a new way to understand, disseminate, and think about our museum collections.

6. Big Bob - an installation created by English designers Martelli/Gibson.
http://www.thedartmouth.com/article/2015/09/big-bob-brings-together-art-and-virtual-reality/

Bruno Martelli and Ruth Gibson, who make up the group Gibson/Martelli, will also be the studio art department's artists-in-residence for the year.

Their exhibition is made up of a giant reclining sculpture, known as "Big Bob," a piece of art mounted on a wall that represents the movement and flaws of motion capture, and three phone applications that allow viewers to see alternate reality figures that move along "Big Bob." Gibson and Martelli said they wanted to explore the idea of intersections of reality and the interplay between audience and art.

While the two artists have been inspired by types of camouflage in the past, they wanted to do a project that used it to create a "liminal performance space" where a performance could occur between the physical and virtual worlds.

The applications they developed for the exhibit will help the viewer enter the virtual world. Among the three apps developed for "MAN A" are the iPhone and Android apps "MAN A" and "MAN A VR", which add the virtual characters into the exhibit space and use special Google headsets to create a virtual reality, respectively. Joining then is the Android-only "RAGTIME VR", an app that creates a virtual reality within the exhibition.

7. Dreams of Dali (2016). 360 video, Oculus Rift & HTC Vive
https://www.youtube.com/watch?v=F1eLeIocAcU
http://thedali.org/exhibit/dreams-vr/

The remarkable marriage of art and technology in *Dreams of Dali*, a virtual reality experience, as you explore Dali's painting *Archaeological Reminiscence of Millet's "Angelus."* Immerse yourself in the world of the Surrealist master like never before in this encounter, venturing into the towers, peering from them to distant lands and discovering surprises around every corner. We imagine Dali himself, known in his lifetime as what we now call an "earlier adopter" of new technology, would applaud this inspiring homage to his 1935 painting.

For a virtually infinite VR experience from anywhere in the world, using HTC Vive or Oculus Rift, click the image below and download the app. Inception provides worldwide fully interactive access to Dreams of Dali. When you can't visit The Dali in person, you may view the linear 360° video from a variety of devices. The linear 360° video can be seen with any VR device, like a Samsung Gear VR or Google Cardboard or Daydream. If you don't have a VR device, you may view on any smart phone, tablet, or desktop PC, using the latest version of Chrome.

8. Ullastret 3D, walk through an Iberian town that existed 2000 years ago
http://patrimoni.gencat.cat/en/stories/ullastret-3d-walk-through-iberian-town-existed-2000-years-ago

Today, thanks to the Patrimoni en Acció (Heritage in Action) programme, which promotes the social use and knowledge of Catalan cultural heritage under the auspices of the Department of Culture and Obra Social "la Caixa", we can see for ourselves what the great Iberian town of Ullastret was actually like.

For the virtual reconstruction of the Iberian city, the specific period around 250 BC was selected, as the most abundant information on the town dated from this era, making for a more faithful reconstruction. The project team, which was made up of archaeologists and 3D modelling specialists, collected all the available archaeological data on the aspects of the city and interpreted them, in order to design and build the reconstruction.

The 3D Ullastret project is characterised by the scientific rigour of its archaeological aspect and by the optimal realism of its visual presentation. Photographs of real materials (soils, walls, stones, etc.) were used, and a very meticulous atmospheric lighting was created, enabling the recreation of a totally realistic texture. The fog, the shadows and the clouds instil the image with realism. Both the streets and the interiors were enhanced with objects from the archaeological holdings on

display at the site's monographic museum, such as amphorae, shields and swords. Other objects, including the carriages and boats, were modelled based on known examples.

Unreal Engine was chosen for its power in creating landscapes and for the quality of its photorealistic results. This sort of tool also makes it easy to create immersive experiences, for example, with the use of the virtual reality glasses by Oculus Rift, Samsung Gear or HTC Vive. A first experience is now available for HTC Vive glasses and is currently on display at specialised conferences within the sector. Other applications are envisaged to be developed in the future, both for the onsite visit and as educational resources for schools, yet always drawing on the fact that this model enables the visitor to stroll through the streets, go inside of the houses and discover the histories of the Iberian town, directly and personally.

9. Valentino Garavani
http://www.valentinogaravanimuseum.com/enter-the-museum

Valentino Garavani, legendary fashion designer, has defined a unique world of couture for almost half a century. Now his achievement takes radical new form, in keeping with the creative traditions of the house: The Valentino Garavani Virtual Museum.

Over 5000 documents have been installed in a 3D Palazzo. One can visit the museum with web browser or download the application on the desktop for an optimized experience, and create the unique route through the galleries, to discover and enjoy every aspect of Valentino's extraordinary world. From a 2018 perspective, its graphic design is a bit outdated, you cannot turn mannequins around and see a dress from all angles.

10. WEVR

https://www.youtube.com/watch?v=A4L_pFSn0xY

WEVR is providing a platform for VR creatives to showcase their work, grow an audience, and encourage a dialogue between the two. They are doing this with Wevr Transport™, an independent, curated network where brave VR can be shared, experienced and celebrated, on all headsets, worldwide. They have developed their own toolkit of best practices to deliver presence with zero nausea for both 360video on mobile HMDs and room-scale interactive VR on PC/console-based HMDs.

Instead of working with a one-size-fits-all set up, WEVR uses a range of cameras including GoPros, machine vision cameras, REDs, and new systems coming to market. Every part of the production process is carefully implemented, all the way from the source camera, to the data ingest process, down to encoding, and ultimately playback and on-device rendering.

They work with Unity, Unreal and their own proprietary Transport™ Engine. VR experiences can be passive or interactive. In passive experiences, the viewer is essentially a fly on the wall, an invisible visitor; they get to sit back and enjoy the experience. Interactive experiences, however, invite the user to participate and interact with the virtual environment and its characters; they are part of the story. Room-scale, interactive VR experiences give the user an added opportunity to move around in an immersive volume, leveraging the sophisticated input controllers provided by the HMD device manufacturers.

11. Tabel Google

https://tabel.withgoogle.com

Tabel is a story that needs to be digested. It is an experience made for immersive VR. The VR format allows user to taste and absorb the cacophony of characters and storylines, while actively participating in the story itself. As the night progresses, chaos gradually engulfs the restaurant and as smoke billows out of the kitchen, users realize that like the other characters in the story, they have also been sitting back while to the drama unfolds. Tabel is an experience that will be felt personally by user, the viewer, as he is the center of the story itself.

Tabel is an experiment in VR storytelling that provides a delectable balance between an interactive and a passive viewing experience using a unique directional audio technique. There are six storylines that unfold simultaneously during the 7 minute film. By looking around, you can choose which stories to listen to by looking in the direction of any character in the film. The directional audio was built specifically for this VR film and it was created and written with this audio technique in mind.

3D modelling fits to ViMM topics: design (interaction design, graphic design) as well as tools (heritage tools that give access to VR/AR).

This contribution is based on research carried out during the eCult Value project (FP7).

More information about different technologies for museums (virtual or real) can be found at: www.ecultobservatory.eu and in particular at: http://www.ecultobservatory.eu/basic-page/ambassadors-toolkit.

12. Museo Stupor Mundi Iesi

https://www.federicosecondostupormundi.it/

Frederic II of Hohenstaufen (1194-1250) was born in Iesi (Italy). This year, they opened a museum that consist to 99% of multimedia tools that tell the story of Frederic II. life in 16 rooms of an ancient palazzo. It uses traditional media (film, photos) and put them together with images taken from books and paintings the times of Frederic II. It uses also virtual reality when showing the books Frederic wrote and where you could browse and read them. This was probably the best part of it in my view as one could read about topics otherwise rather unknown, e.g. the role of women in law, medicine treatise and the art of falconry, all written by Frederic II. Basically, it is a storytelling at its best. There are overall very positive opinions on TripAdvisor (which gives a good indication of user acceptance). It is probably one of the rare cases where a "virtual museum" is housed in a building like a real museum.

13. Virtual Pompei

https://www.viator.com/tours/Pompeii/3-Hour-Private-Pompeii-Tour-with-3D-Virtual-Reality-Headset-Tour-Assistant-Only/d24336-17264P5

Discover the archaeological ruins of Pompeii, a UNESCO World Heritage site, on a private tour using a 3D virtual reality headset. Go back in time on this immersive, 360-degree experience that shows you Pompeii as it once was, just before it was destroyed by the eruption of Mt Vesuvius in 79 AD. Wearing the headset, you'll watch short historical re-creations of Pompeii's main points of

interest. Audio commentary enhances the experience. This tour does not include a guide; you'll be escorted by an assistant, who cannot answer questions or provide historical information. Highlights Choice of morning or afternoon departure Small group ensures personal service Step back in time on a history tour All entrance fees included Skip the line Soak up the atmosphere on a walking tour.

14. Cave Lascaux - Visite virtuelle

http://archeologie.culture.fr/lascaux/en/visit-cave/salle-taureaux-0

https://www.youtube.com/watch?v=wLuh_lEDSTc

https://www.youtube.com/watch?v=QrOQiknOE9w

All of Lascaux is revealed. A complete new replica retraces the discovery of the famous decorated cave. The entire site inquires into the position that Lascaux occupies in cave art and its relation to contemporary creation. The opening of the International Centre for Cave Art marks the beginning of a new adventure combining the emotion of ancestral art and an important technological achievement.

The complete replica of the original cave is the culmination of three years of work in the Perigord Facsimile Studio. This new space welcomes visitors, inviting them to contemplate the works and experience the authentic emotion felt at the discovery of the cave, to observe, to enquire into the reasons for its existence and to reflect on the environmental and cultural context in which it was decorated.

The architecture of the International Centre forms an integral part of the visitor's experience: a half-buried building at the foot of the Lascaux hill, it is perfectly integrated into the landscape. A gigantic glass front invites the public to visit a universe firmly focused on technological prowess. The various spaces with their uncluttered style and modern aesthetics contain the latest digital tools (enhanced reality, 3D screens, etc.). They incite the public all through the visit to enjoy an immersive and personalized experience.

Cave contains more than 6,000 paintings and 1,500 engravings that are carved into the walls of the cave. Most popular drawing is the horse, followed by the bison.

Users can watch the Youtube video Lascaux's Prehistoric Cavepaintings. Then one can go to the Lascaux website and take the virtual tour.

User Experience (15 cases)

User Experience (UX) refers to a person's emotions and attitudes about using a particular product, system or service. It includes the practical, experiential, affective, meaningful and valuable aspects of human–computer interaction and product ownership. Additionally, it includes a person's perceptions of system aspects such as utility, ease of use and efficiency. User experience may be considered subjective in nature to the degree that it is about individual perception and thought with respect to the system. User experience is dynamic as it is constantly modified over time due to changing usage circumstances and changes to individual systems as well as the wider usage context in which they can be found. In the end user experience is about how the user interacts with and experiences the product. (From Wikipedia, the free encyclopedia)

Here a focus is on mixed reality and on dramaturgy and setting of the experience.

1. Vuforia
https://vuforia.com/content/vuforia/en.html

https://www.youtube.com/user/vuforia

Selected because it provides a free and stable AR SDK. Using the Vuforia platform, your app can see a wide variety of things, and we're continuing to work on expanding our recognition capabilities all the time.

- Recognize and track a broader set of objects so you can bring toys to life and add digital features to consumer products.

- Images with sufficient detail including magazines, advertisements, and product packaging can be recognized. The Vuforia Target Manager helps you analyze and improve your images to optimize your app's performance.

- User-defined images give users the ability to create basic AR experiences that work anywhere. It's as simple as taking a picture of an everyday object, such as a book page, poster or magazine.

- Cylinders such as bottles, cans, cups and mugs can be recognized.

- Supports English word recognition from a standard database of ~100,000 words or a custom vocabulary defined by the developer.

- Simple boxes with flat sides and sufficient visual details can be recognized.

- VuMarks allow the freedom for a customized and brand conscious design while simultaneously acting as an AR target. VuMark also provides a simple method for encoding data such as a URL or a product serial number.

- Smart Terrain is a new capability for smart phones and tablets that reconstructs a terrain in real-time, creating a 3D geometric map of the environment. This gives apps the ability to interact with various surfaces and objects. It allows developers to build dynamic gaming experiences where game elements interact with the physical world; characters can navigate around, collide with and jump over objects.

- Extended Tracking is a capability that delivers a continuous visual experience even when the target is out of view so users have the freedom to follow game play over large areas and visualize large objects such as architectural models, vehicles and furniture.

2. FIFA Museum

https://itunes.apple.com/US/app/id1076588391

The gaming community is expecting a lot of new changes in 2017 like 4k HDR rendering games, the realistic of graphics and gameplay but the one that is most anticipated is Virtual Reality. FIFA said that another new feature for 2018 will allow fans to also follow the matches in virtual reality – both as a live experience and as 360° video-on-demand. In terms of TV coverage, each match will be covered using 37 cameras – including eight with UHD/HDR and 1080p/SDR dual output, another eight with 1080p/HDR and 1080p/SDR dual output, eight super-slow-motion and two ultra-motion cameras.

3. Meeting Rembrandt

https://www.oculus.com/experiences/gear-vr/1297352360374984/

video: https://www.youtube.com/watch?v=Icpp9C41ZjQ

Focused on mixed reality and on the dramaturgy and setting of the experience.

Rembrandt van Rijn is one of the world's most famous painters and one of the earliest masters of creating 'virtual reality'. What if you could have the chance to meet him? Live a moment in time with the famous 17th century master painter and get close up and personal as he changes history forever with his controversial painting, the Night Watch. You are there! Travel back in time and feel what life might have been like in 1642 during the Dutch Golden Age. Go inside the house of Rembrandt to get a glimpse into the life of one of the most famous painters of all time. Be a part of the movie as Rembrandt responds to your actions bringing an extra level of immersion to the experience. The rich environment you enter into is visually stunning because of the unique techniques used to heighten the quality to the highest level possible on the Samsung Gear VR.

4. Weltatem
http://www.monobanda-play.com/project/weltatem

http://waag.org/en/blog/intimacy-virtual-reality

A theatrical experience where the audience is participating and singing together with professional opera singers (2016). In this opera show 30 audience members put on VR helmets and play a game that they control with their voice. This dreamlike game asks them to sing, modulate, and harmonize. At the same time, the sound that these players make creates a musical composition together with the singing of the real opera singers. Which in turn becomes a haunting experience for the onlooking audience that sees individual amateurs slowly becoming one with an opera choir.

5. Vermillion Lake - an installation created by English designers Martelli/Gibson

https://vimeo.com/27818895

http://gibsonmartelli.com/portfolio/vermilion-lake/

Vermilion Lake comprises a full-scale replica of a trappers cabin housing an interactive virtual environment. Inside the cabin there is a boat. The visitor is rowing a boat to be able to travel through the landscape.

6. Into the Wild

https://www.mediamonks.com/vr-ar/work/artscience-museum-into-the-wild

http://www.marinabaysands.com/museum/into-the-wild.html – w6QcqfRvR0yJCsW9.97

Into the Wild is a mixed reality experience taking place in Singapore's ArtScience Museum. Visitors can freely explore an immersive exhibit in which the entire museum transforms into a virtual rainforest, thanks to Tango. The app tracks motion and understands depth, distance travelled and objects inside the museum-turned-rainforest. The rainforest is inhabited by endangered animals people can interact with to learn about the dangers they face from human impact. Into the Wild becomes a reality when the virtual tree that people can plant as a symbolic act becomes a real tree in Sumatra donated by the project's sponsors.

7. Tango

https://get.google.com/tango/places/

https://www.youtube.com/watch?v=pprT5GIFxiI

Selected because it is a very powerful tool to map a building and provide visitors with a stable AR experience. Museums build Tango experiences to give visitors a new way to explore their exhibits. hold up your phone, and watch as virtual objects and information appear on top of your surroundings And they have Tango phones that anyone can use. Just drop in, grab a phone, and start exploring: Detroit Institute of Art, ArtScience Museum Singapore, Computer History Museum, Mountainview CS

8. 3D reconstruction of Amrit

https://vimeo.com/163516926

Heritage & innovation: superb 3D reconstruction of the archaeological site of Amrit (Syria).

9. Experience Tesla: Virtual Reality Museum

http://nikolateslamuseum.org/web

The aim of the project (curated by Nikola Tesla Museum, Belgrade) is to present the great inventor Nikola Tesla in innovative way, using modern solutions: presenting the great man as a person, as a genius and the one that "shaped the future as we know today". Using VR/AR tools and technologies, Experience Tesla shows a great combination of online and smartphone storytelling through VR media presentation of heritage of Nikola Tesla. Visitors can choose to use cardboard VR googles or to use the online digital storyboard.

10. Lumin – Detroit Institute of Art

https://www.dia.org/about/press/media-kits/lumin
https://mw17.mwconf.org/glami/lumin/

https://www.dia.org/about/press/media-kits/lumin

Selected because it is the first art museum in the world to integrate 3-D mapping and smart phone augmented reality technology into a public mobile tour, providing visitors with a novel user experience. The Detroit Institute of Arts (DIA) premièred a mobile tour on Jan. 25 called Lumin that uses Google's Tango technology to provide visitors with new, in-depth ways to engage with the DIA's renowned collection. The DIA is the first art museum in the world to integrate this 3-D mapping and smart phone augmented reality (AR) technology into a public mobile tour.

Whether it's a view of a mummy's X-ray or a walk through the gates of Babylon, the experiential, educational, and engagement potential is nothing short of astonishing. And on a practical level, Lumin helps visitors navigate the museum, and can be useful for hearing or visually impaired guests, as well. No matter how it's used, the technology provides an undeniably enriching experience – and its capabilities only show the tip of the iceberg.

"Augmented reality allows the user to see the unseen, imagine art in its original setting, and understand how objects were used and experienced in people's everyday lives. It's an exciting way to incorporate the latest technology into the visitor experience." (Salvador Salort-Pons, DIA Director).

11. MAV – Museo Archeologico Virtuale (Virtual archaeological museum), Ercolano (Italy)
http://www.museomav.it/?lang=en

https://www.youtube.com/channel/UC4lsWIkYUuu4AQxuizxQ9Hg

It proposes a highly engaging visitor experience mostly relying on VR.

The MAV is located a few steps away from archaeological excavations of ancient Herculaneum. It is a center of culture and technology applied to cultural heritage and communication among the most advanced in Italy. Inside is a unique and extraordinary museum: a virtual and interactive tour where the excitement of an amazing journey back through time just before the Plinian eruption in 79 AD that destroyed the Roman cities of Pompeii and Herculaneum.

More than seventy multimedia installations returned life and splendor to the main archaeological sites of Pompeii, Herculaneum, Baia, Stabiae and Capri.

Through reconstructions, visual interfaces and holograms, the visitor, conducted into a virtual world can experiment through play and interaction new media opportunities that technology offers for the enjoyment of the archaeological patrimony.

12. Basquiat: Boom for Real
https://www.barbican.org.uk/whats-on/2017/event/basquiat-boom-for-real
presentation video

The first large-scale exhibition in the UK of the work of American artist Jean-Michel Basquiat (1960—1988) in Barbican, UK, available also in 360 exhibition tour.

Discover the work of Jean-Michel Basquiat, the pioneering prodigy of the 1980s downtown New York art scene. This unprecedented exhibition brings together an outstanding selection of more than 100 works from international museums and private collections.

Join Barbican curator Eleanor Nairne and Gus Casely-Hayford as they look around the 'Encyclopedia' room in our Basquiat: Boom For Real exhibition and discuss the wide range of influences Jean Michel Basquiat brought into his paintings.

13. Nexto powers top cultural and natural heritage destinations in Slovenia
http://nexto.io/

Improving visitor engagement with heritage content has always been one of our key goals. We believe in the power of storytelling. When stories are well told, they have the ability to draw you in. Only well told stories are truly relatable, memorable and leave a lasting impact.

Guided tours have a new look. You are now able to connect points of interest in a linear sequence and create routes on the map of your destination. You visitors will be able to navigate through the designated paths smoother and easier. Guided tours are clearly marked in the app. You can create as many of them as you wish. You can label them with an approximation of their duration or have them locked and offered to your visitors as premium, payable content. The Ljubljana Castle, one of most popular tourist attractions in Slovenia has joined the Nexto platform. By utilizing Bluetooth beacon technology, the castle now offers a unique hands-free audio tour experience, that will guide visitors through the history and secrets of this mighty fortress. Rich multimedia content, clearly marked maps and the support for over 10 lanugages, make Ljubljana Castle one of the best Nexto experiences so far.

14. Rethinking Guernica: Museo Nacional Centro de arte Reina Sofia
http://guernica.museoreinasofia.es/en#investigacion
http://guernica.museoreinasofia.es/gigapixel/en/#5/39.529/-157.192

Transcending the specific event it was based on, *Guernica* is a timeless, universal symbol, vilifying the implacable and criminal destruction of war, and opening artistic debate on the representation of armed conflict. This website presents the extensive research conducted on the artwork, a twentieth-century icon, by the Museo Reina Sofía, and comprises around 2,000 documents**.** Follow the guidelines to get the most out of the Guernica Gigapixel images.

15. Berlin Wall: The Virtual Reality Experience
http://www.newseum.org/2017/07/26/berlin-wall-vr-experience-now-open-at-the-newseum/
Vive Studios has announced a new funding and development program that seeks to get virtual reality experiences to more people in the form of art installations and VR museum exhibits. The HTC subdivision announced early partnerships for the initiative with museums such as the Somerset House in London, and The National Palace Museum in Taiwan.

Vive Studios was created in December of 2016 to kick-start first-party content for the HTC Vive VR headset. In contrast with the HTC Vive's partnership with game company Valve, Vive Studios was started with the specific goal of expanding VR experiences beyond the realm of gaming.

Outside of Vive Studios, HTC sponsors Vive X, a global accelerator program with the goal of cultivating "the VR startup ecosystem." The company seems determined to not only expand access to VR experiences, but also make sure HTC plays an important role in shaping the future of the medium.

The exhibits would be supporting the HTC Vive headset, but also they confirmed that museums and art galleries have expressed interest in the future standalone VR headset from HTC, which has yet to be unveiled. It's a big move to ensure that HTC and Vive Studios stay relevant in the future of the VR space.

Tools - heritage tools that give access to VR/AR (14 cases)

- tools required by cultural heritage to create AR and VR
- workable framework for image rights and the ability of museums to support new IC technology
- computerized cataloguing (libraries)
- computerized bibliography (libraries)

The task force formulated recommendations regarding 'audiovisual content in Europeana' in three specific areas:

1. Improving the use improving search on time-based media (including an assessment of audiovisual media standards in relation to EDM), Multimedia hyperlinking (incl. definition of a pilot / exhibition), Crowdsourcing

2. Accessibility Support of subtitles and multilinguality emerging media formats (playout on mobile devices)

3. Editorial How to embed audiovisual content in Europeana Collections and other Europeana-related sites reusing AV materials assessment of multimedia content (topics) editorial use of AV content externally (length, edit)

Augmented Reality (AR) is a (live) view of a physical, real-world environment whose elements are *augmented* (or supplemented) by software-generated data such as sound, video, or (3D) graphics. As a result, the technology functions by enhancing one's current perception of reality.[By contrast, virtual reality replaces the real world with a simulated one]. (Source: Wikipedia)

AR in a cultural heritage context can be used in three main ways: Outdoor guides: they take advantage of the user's geo-location and point to monuments or places of interest, often through images from the past; Interpretive mediation (of a museum, collection of exhibition) aka Storytelling: enhance the experience of users thanks to a profiling and related choices of museum paths or artefacts combined with narratives, or use it to reinvestigate the past; and new media art/virtual exhibitions: the use of AR in the creation process and/or the featuring of this art in overlaying it in public or exhibition spaces.

https://pro.europeana.eu/project/audiovisual-media-task-force

For cultural heritage and museums, most exciting use cases would include: Virtual reconstruction whereby AR is used to show things at scale, such as a building, room or massive objects like ships, using 3D models. A good overview gives the article of Stuart Eve (University College London) that includes the Museum of London Street Museum and the CHESS project at the Acropolis Museum. In addition, you may want to read about "Dead men's nose", a way to enhance the experience of AR through smells, quite intriguing. AR can be also used to bring extinct animals back to life (see, for example, the dinosaurs at Ontario Museum). AR for storytelling and interpretation that allows for tailor-made, user-centric itineraries through collections. AR storytelling using tablets is one of the success stories of the CHESS project that was listed by The Guardian (2014) among the 10 R&D

technologies that are changing arts and cultureThe EU-funded Chess project (a shorter name for the much longer Cultural Heritage Experiences through Socio-personal interactions and Storytelling) takes digital storytelling much further and plans to make interactive content such as games and augmented reality available to the entire museum sector.

1. CHESS project: AR on tablets for the collection of the Acropolis Museum.
http://www.chessexperience.eu/

The project relies on visitor profiling, matching visitors to pre-determined "personas" – which are designed as a representative description of the various people that constitute a given museum's visitor base. These are created through data from surveys, visitor studies and ethnographic observations. A given visitor is matched initially through a visitor survey to one of several representative personas, which in turn influences fundamentally the experience delivered by the Chess system.

Doing this makes the visitor experience non-linear. The system constantly adapts to a visitor's preferences. For example, if a visitor fails in a game or stays longer in front of certain artefacts, the system can adapt the storyline. It makes the experience more dynamic and relevant, so instead of sending the visitor to X exhibit, the system might instead choose to send you to Y exhibit, where you will get more information that's relevant to what you've shown an interest in.

Interactive tours can be created by the museum curators themselves rather than by IT programmers. It gives museums the chance to constantly create new experiences to try to get people to visit more than once.

We've been testing the project at the Acropolis Museum in Athens, Greece, where the team used the technology to bring a collection of architectural and sculptural remains to life by using AR to restore colours and lost features.

2. TechCoolTour project: Roman and Byzantyne itineraries app with AR
http://www.techcooltour.com/en/project/about

The project "TECH -TOUR Technology and Tourism: Augmented Reality for Promotion of Roman and Byzantine Itineraries" aims to promote two historical trans-national EU cultural routes exploiting developed ICT tools and exploring new media potential in promotion of cultural heritage. Retracing the history of influences, exchanges and developments of two great empires, Roman and Byzantine, which shaped the cultural landscape of Europe, the project aims at defining the common thread that link places and regions and helps represent the richness and uniqueness of European cultural identity.

Within the project, twelve archaeological sites in four countries are marked with Augmented Reality info boards. When viewed through smart phone, the boards trigger virtual presentations and offer additional info to visitors, thus transforming the routes into virtual open air museum. Download and install the free TECHCOOLTOUR application from Google Play or App Store.

3. Fraunhofer CultLab3 3D scanning Lab

http://www.cultlab3d.de/

In the museum sector, demand for a fast and economic 3D digitization technology for cultural heritage artefacts becomes increasingly important. Yet in contrast with the digital acquisition of cultural goods in 2D efficiently put into practice and widely-used today, 3D digitization is still connected with an enormous expenditure of time and money.

Against this background, the modular scanning pipeline CultLab3D, which digitizes three-dimensional artefacts in 3D with millimetre accuracy in an automated process, is developed by the Competence Center Cultural Heritage Digitization at the Fraunhofer Institute for Computer Graphics Research IGD. For a photo-realistic rendering of the objects, their geometry, texture and optical material properties are incorporated. By automating the entire scanning process, the aspect of fast and efficient 3D mass digitization is implemented for the first time.

CultLab3D was recognized with the „2013 Digital Heritage International Congress and V-MUST.NET" award for best technical exhibit at the "Digital Heritage 2013". This conference is the biggest event on digital cultural heritage and is organized under the patronage of UNESCO.

4. 3DHOP – 3D Heritage Online Presenter
http://3dhop.net/index.php

https://www.vi-mm.eu/2017/09/26/3dhop-3d-heritage-online-presenter/

It is an open-source software package for the creation of interactive Web presentations of high-resolution 3D models, oriented to the Cultural Heritage field. *3DHOP* target audience goes from the museum curators with some IT experience to the experienced Web designers who want to embed 3D contents in their creations, from students in the CH field to small companies developing web applications for museum and CH institutions.

3DHOP allows the creation of interactive visualization of 3D models directly inside a standard web page, just by adding some HTML and JavaScript components in the HTML code. The 3D scene and the user interaction can be easily configured using a simple "declarative programming" approach, and by a series of provided JavaScript functions.

By using a multi-resolution 3D model management, supporting an efficient streaming, 3DHOP is able to work with high-resolution 3D models (1-100 millions of triangles) with ease, also on low-bandwidth. 3DHOP does not need a specialized server, nor server-side computation: simply some space on a web server. and does work directly inside modern web browsers, no plug-ins or additional components are necessary. Here are some examples of their works. Since it is an open source tool, users can download the latest version of 3DHOP here.

5. European cemeteries walk with ARtour – Augmented Reality Navigation
http://eucemet.blogspot.com/p/about.html

https://www.vi-mm.eu/2017/09/20/european-cemeteries-walk-with-artour-augmented-reality-navigation/

In Europe, through their structure (architecture, sculptures and mausoleums, green areas, churches, etc.) many significant cemeteries are aclear demonstration of the artistic evolution of the continent, mostly between the Romanticism and Modernism (19th and 20th Centuries). Their buildings – often made of a wide range of materials, from local stones to marble and iron to bronze -, have involved

some of the most important sculptors and architects, and often served to "immortalised" the life, death and achievements of local citizens. In fact, the different experts on such issues do not talk about "tombs", but about "monuments", and some cemeteries have even reached international recognitions. This mobile app provides additional information on the screen as a user walks around. So, helping a user to get somewhere and learn something on the way was the main reason why ARtour mobile app was born and created.

Within the EUCEMET project the partners consortium has discovered that mobile guides are at the beginning of their development path. Although there are so many mobile solutions out there, we still have so much more to offer to the users. There are many small technical issues like Augmented reality usability or GPS and compass accuracy that impact the overall usability of such apps. On the other hand, users are not really in favor of holding their mobile devices in hands all the time and looking at the screens while walking around.

Today, after several alterations and updates, ARtour is a mobile guide app with Augmented Reality, dynamic maps, smart notifications and many other features. It offers functions such as: planning personal trips online, working with a team on Field Research Projects, showing the guides in websites, etc. Yes, it is an overwhelming platform with so many more amazing features. If you are interested, simply sign in and start Learning by moving.

6. Digital Library of Slovenia

https://www.vi-mm.eu/2017/09/20/digital-library-of-slovenia/

The Digital Library of Slovenia (short: dLib) is an Internet service—since 2006 a part of European Library—that allows access to digitalized material from the National and University Library of Slovenia.

Since 2005, its web portal offers a free search through sources and free access to Slovene newspapers, periodicals, books, manuscripts, map, photographs, music and manuals, and other resources: articles from older Slovene newspapers; more than 10,500 items in the photos collection, which includes the photos of caricatures, drawn by Maksim Gaspari and Hinko Smrekar; reproductions of Ivan Cankar's drawings and manuscripts; and postcards with Jurij Vega, France Prešeren, and old Ljubljana books from 1830 until today provides free access to some of the most important works of the Slovenian authors; more than 3,000 scholarly articles published in many internationally recognised professional and scientific journals; a collection of 4,000 advertising, promotional, film, and war posters; more than 1,000 items of sheet music, including one of the first arrangements of Prešeren's Zdravica (Slovenian national anthem); compositions by the Slovenian composers; and arrangements of the Slovenian folk songs and the songs from the turning points in the Slovene history; the selection of old maps, including Valvasor's maps of Carniola, and old city plans of Ljubljana (from 1820 to 1920); recordings of solo singers and ensembles dating from the beginning of the 20th century, including a wide range of Slovene folk songs.

7. Viar360 "Create your first VR experience"

https://www.vi-mm.eu/2017/09/20/viar360-create-your-first-vr-experience/

Viar360 is the authoring & publishing platform for 360 virtual reality:

- Drag-and-drop editor,
- Add hotspots to 360 videos,
- Cross-platform distribution,
- LMS & CMS integration,
- Insightful analytic

8. The Best in Heritage: Projects of Influence

https://www.vi-mm.eu/2017/08/30/the-best-in-heritage-projects-of-influence/

Evey year is there, the most innovative museums can apply for new state of the art museums, for different readsons, not only for technology. If museum is listed there, it could be an indicator.

9. Museum haunted house is a scary virtual-reality journey

http://www.chron.com/entertainment/article/Museum-haunted-house-is-a-scary-virtual-reality-12305509.php

It may take place within a small carpeted space, but the new virtual-reality exhibition at the Houston Museum of Natural Science opens up a wide world that heightens the senses. Through Halloween, the exhibition's big draw was the virtual-reality haunted house. Visitors strap on a backpack and a mask to begin their journey.

The instructions from the museum staff are simple: Follow the bloody footsteps. Raise both hands if you're frightened and want to leave the haunted house. Raise only one hand if you get lost and need to be redirected. And, remember, there are no walls inside.

Even with this intellectual knowledge, you can find yourself "pushing" open doors, carefully stepping along narrow planks to avoid plunging into boiling water and dodging a host of ghastly creatures.

The haunted-house experience is recommended for ages 8 and older, and it's not for the faint of heart. Children who would be spooked in a traditional haunted house will be just as scared, if not more so, in this one. Still, museum docents say children as young as 5 have explored the haunted house and asked to go again.

Outside of the haunted house, the exhibition includes several virtual-reality kiosks and games and an augmented-reality screen. Admission is separate from regular museum prices because the experience is designed to be stand-alone.

10. ZEPHVR
https://zephvr.co/#about

Meet the new accessory that lets you actually feel virtual reality . The ZephVR is a first-of-its-kind accessory that automatically adds wind to any VR game. Using machine learning, the ZephVR recognizes events in games' audio tracks and activates its fans at the right moments. So when you fly, fall, or accelerate—or when there's wind in a game—you'll actually feel it. The team behind a new accessory for virtual reality headsets that will create wind and synchronize it to VR events, immersing users even deeper into the VR content, came up with the idea for their gadget by

happenstance. What they came up with are two 40-millimeter fans the users would buy and then attach to whatever VR headset the own. The fans would sit below the head-mounted display, listen for wind in audio games and trigger themselves accordingly.

11. Prezi Next wants to bring audiences inside of a presentation using augmented reality

https://prezi.com/augmented-reality/
https://prezi.com/business/kb/get-started/get-started/

As high as Prezi has climbed, Microsoft PowerPoint is still the market leader. It has hundreds of millions of users—most of them creating the same boring slideshows Arvai has vowed to make extinct. So in order to take that next step and become the top name in presentation software, Prezi needs to evolve. How could Arvai and his team create tools to make presentations even more immersive, more exciting? The answer: bring audiences *inside* of the presentation using augmented reality.

Prezi Next is the latest generation presentation platform built on HTML5 technology, which gives user a consistent, high resolution, and smooth experience for their conversational presentation needs. It helps engage the audience in the story. Whether you're giving a pitch to a potential client, training employees, or outlining future business plans, Prezi Next will help you convey your message in a memorable way through conversational storytelling.

12. Inde – Augmented Reality company

http://www.indestry.com/
https://www.youtube.com/watch?v=dsool95S02I
https://www.youtube.com/channel/UCT9_9BwsuTg3UQuT4SdrZbA

Selected because it provides a different view on augmented reality: not a subjective view of digital contents superimposed on reality (mobile AR) but the user superimposed on a virtual world (augmented virtuality). Augmented reality, motion capture and computer vision – to create next-generation platforms that change the way people interact with digital content.

Since 2011 they have launched augmented reality systems in over 40 countries for clients such as American Express, 20th Century Fox, National Geographic, Coca-Cola, WWF, Smithsonian Institution, Universal Studios, BBC Worldwide, GE and Guinness Book of World Records amongst others.

Advancing the camera on android phones:
http://www.prnewswire.com/news-releases/qualcomm-first-to-announce-depth-sensing-camera-technology-designed-for-android-ecosystem-300504239.html

13. Wingnut Arkit

https://www.youtube.com/watch?v=S14AVwaBF-Y

Apple's ARKit was recently launched at WWDC with Alasdair Coull from Peter Jackson's augmented reality studio Wingnut AR demoing live at the show.

The ARKit is a framework for building AR applications and games. IOS 11 introduced ARKit, as a new framework to easily create augmented reality experiences for iPhone and iPad. By blending digital objects and information with the environment, the ARKit uses Visual Inertial Odometry

(VIO) to accurately track the world around it. VIO fuses camera sensor data with CoreMotion data and lets creators lock their digital content onto some kind of object such as a tabletop, and then track the iPad or iPhone camera as someone moves the device around.

With ARKit, an iPhone or an iPad can analyze a space presented by the camera and find horizontal planes in the room. ARKit can detect horizontal planes like tables and floors, and can track and place objects on smaller feature points as well. ARKit also makes use of the camera sensor to estimate the total amount of light available in a scene and applies the correct amount of lighting to virtual objects. ARKit runs on the Apple A9 and A10 processors.

14. Attenborough VR experience

http://www.nhm.ac.uk/about-us/news/2015/june/dive-back-in-time-with-david-attenborough-s-first-life.html

First Life is a virtual tour of the world 540 billion years ago . Visitors to the Natural History Museum will be able to get eyes on with a new virtual reality exhibition, thanks to a new 15 minute experience narrated by Sir David Attenborough. *First Life* takes viewers back in time to the beginnings of life on earth, revealing some of Earth's earliest organisms 540 million years ago, and charting their evolution into the first animals. The experience uses Samsung Gear VR headsets, which were lauded for their portability and suitability for families visiting the exhibit by Sir Michael Dixon, Director of the Natural History Museum. It's certainly an immersive way of learning about Earth's earliest species, which were previously only accessible through fossils and static exhibits. Narrated by the iconic nature commentator, and created with Atlantic Productions, this 15-minute adventure allows visitors to explore ancient oceans and interact with sea creatures that existed more than 500 million years ago. Based on the Museum's latest ground-breaking research into the physiology, evolution and behaviours of ancient animals, long-extinct creatures such as the fearsome-looking *Anomalocaris* and the spiny, worm-like *Hallucigenia* have been vividly brought back to life using virtual reality technology. After a short video introduction from Sir David Attenborough, visitors are taken on a journey through Earth's Cambrian Period oceans, using Samsung Gear VR headsets.

User Interaction - social media, community building, gamification, citizen science etc. (15 cases)

http://edutechwiki.unige.ch/en/User_interaction_and_user_interface_design

User interaction design can be achieved through tools like interactive mock-up design or model-driven user interaction design languages, such as OMG's IFML (Interaction Flow Modeling Language, OMG, 2014). Interaction design is a discipline which examines the interaction via an interface between a system and its user.

Social networks are popular platforms for interaction, communication and collaboration between friends. Researchers have recently proposed an emerging class of applications that leverage relationships from social networks to improve security and performance in applications such as email, web browsing and overlay routing.

Gamification principles:

- Does the user have a sense of presence in the interface?

- Are your goals clear, challenging, and surmountable?

- Do you provide instant, gratifying feedback?

- Do you leave room for failure?

- Are there opportunities to explore and play?

- Do people feel like they take something away from your interface?

- Have you given people the opportunity to interact with other people?

Building a community: be ready to commit, to invest the patience and effort it takes to build a community. This is really important to consider as it will condition the success of your project. Then, it is very important to clearly define the subject that will bring the members of the community together.

Blogs, website, social media pages with a large and strong community tend to revolve around a specific engaging subject. You have to choose who you want to reach and find that common value that brings people of similar interests together.

Obviously, a spontaneous group is easier to manage than one requiring incentives but, in the case of a branded app, you can still create a sense of belonging with your audience! Many big international brands have achieved success through this strategy. If adhesion can be spontaneous, nurturing your brand followers is essential, with special offers, a loyalty card or membership levels...

In any case, here's two aspects you should not overlook:

- Offering brilliant, useful and informative content.
- Offering different tools for everyone to interact, the more options the better.

With an [app builder](#), you can easily create a wonderful architecture for your content, but it remains up to you to deliver good quality content. The best design or user experience can never make up for a lack of relevant content. For more tips, check out our [Content Creation Tutorial](#).

Besides, you need to make it possible for users to interact with your content, through comments, and share it, so that your message goes farther than the app, the best form of low-cost communication. On top of that, to make your app more social, consider enabling our Chat Add-On. You can also set up a Submission section and encourage users to submit content from the app (text, photo and video formats are supported). UGC (User Generated Content), using hashtags wisely, these are all powerful allies to build a community inside and outside of your mobile app. https://blog.goodbarber.com/How-to-Build-a-Community-Around-Your-App_a462.html

1. Rijks Studio

https://www.rijksmuseum.nl/en/rijksstudio

One can browse through 618.913 works of art and 377.220 Rijksstudios. Rijksstudio contains 125,000 beautiful, well-known, and surprising images from the Rijksmuseum's collection. You can zoom in really close, share them, and 'like' them. You can also create collections of your own, using your favourite images and details. Not only that, but the Rijksmuseum is also inviting you to use these images to create beautiful products.

Rijksstudio is an innovative digital application that makes a large part of the museum's collection available to all, absolutely free of charge. Well- and lesser-known pictures can be examined in close detail. Users can interact with them, "like" them, share them with others and use them in any way they wish.

Rijksstudio is a unique project by virtue of the quality of images, interaction with the public, and concept of "closeness" forming the guiding principle of Rijksstudio, which is borne out at various levels. In practice, this entails:

- A focus on the image.

- High-resolution images (2500 x 2500 pixels, 300 dpi) which are of real value to the user. The Rijksmuseum now allows free use of 125,000 high-quality digital reproductions, with absolutely no limitations. These are not "thumbnails," and there are no watermarks or sharing restrictions.

- Rijksstudio invites the public to enjoy and explore the images: zoom in, save, manipulate, and share. Users are encouraged to download the images and to do something—anything you like—with them. The Rijksmuseum is "democratizing" its collection.

- An "ambassador campaign" has been launched to promote Rijksstudio. Well-known artists were asked to produce a work inspired by the Rijksmuseum's collection. A real-world pop-up Rijksstudio visits locations such as the De Bijenkorf department store, where visitors are invited to produce their own artwork.

- The new Rijksmuseum website and Rijksstudio have been developed according to the principles of an app. The priority is ease of use and control, whereby all tasks can be undertaken with a minimum of user interaction. Touchscreen control, inspired by iPad apps such as Guardian Eyewitness, in which the full-screen image is not obscured by information

or function buttons, is new to the museum world. The website is also fully responsive: it works well on (almost) all devices.

2. Microrangers

https://www.amnh.org/learn-teach/families/microrangers/

This is American example from Natural history museum, AR game, discovery game inside the museum. They use digital artefacts and models to create stories. One of the best examples for gamification. Social dissemination of contents.

MicroRangers is a new mobile game at the Museum that shrinks visitor down to microscopic size and sends him into exhibits to combat threats to biodiversity. Nine MicroCrises await—real-world scenarios involving microorganisms— starting in the 1st floor Hall of Biodiversity. For advanced game players, marshall your resources to take on the 6th Extinction. Armed with the mobile app and a free Communicator Coin, augmented characters - both microbes and scientists - will send you on missions and help you along the way. Have fun while you learn how even the smallest things can make a big difference.

MicroRangers employs a range of technologies to: geolocate you within the Museum, offer augmented animated characters to guide you, and provide mini-games that bring the dioramas to life.

3. Any Gallery Online – No real space needed

https://exhibbit.com/home

Kunstmatrix is a unique tool that enables registered users to create beautiful 3D showcases of their art to impress art lovers and collectors. Digitally presented and managed art, including an augmented reality app to show a preview of the works in any (virtual) space. With the latest 3D technology platform allows previews and presentations of artworks wherever and at any given time. A library of exhibition rooms offers a wide range of architectural spaces — suitable for every kind of art. One can choose between wall colours and combine different rooms into a large exhibition. It is possible to arrange, curate and archive exhibitions in 3D virtual exhibition rooms, choosing from a variety of pre-configured rooms or designing own exhibition architecture. The small drawback is the fact that it is a payable platform. But if smaller galleries don't have the technical equipment and human resources to produce their own virtual spaces, it could be a useful solution.

4. National Gallery live on FB

https://www.vi-mm.eu/2017/08/25/national-gallery-live-on-fb/
https://www.facebook.com/thenationalgallery/

The National Gallery has been hosting live online tours via Facebook Live for just over a year. We have hosted broadcasts from inside our exhibitions and around our collection, led by our curators, education team, Director and Deputy Director. In a short space of time, live video has also become a key way we communicate with their global digital audience, allowing National Gallery to share with thousands of people art and the knowledge of those who work here. Their most popular live video so far, led by the Director Gabriele Finaldi, received over 200,000 views with 5,000 people watching all the way until the end of the 15-minute broadcast.

5. Father and son
http://www.fatherandsongame.com/
https://youtu.be/6guDCiNkZr0

Created not directly for the museums, interactive story that will tell the story of Naples through the story of the father and the son. Very well designed, a good example of engagement of people. It encourages people to go to the museums. Gamification of things. Father and Son is an adventure that takes off from the National Archaeological Museum in Naples, a cultural institution housing some of humanity's greatest artefacts and treasures. What begins as the story of a son who never knew his father becomes a universal and ageless tale, with the present and the past making up the setting for Michael's travels. Seek for yourself the beauties of Naples, experience the last hours of life in Pompeii before Mount Vesuvius erupted in 79 AD, and explore the ordinary day-to-day life in Ancient Egypt. The past is what makes our present real. Completion time: 50-60 minutes. Some sections of Father and Son are unlocked by checking in at the Archaeological Museum of Naples, publisher of the game. The Father and Son soundtrack is available for download on the official site.

6. Amsterdam DNA: Stories from Amsterdam
https://www.codart.nl/museums/amsterdam-museum-presented-its-new-look-this-weekend-amsterdam-dna/

Not VR/AR, it started from Museum of Amsterdam in 2011, to document the story of districts of Amsterdam. All people started to upload the stories and photos from different times about the district. They are also opened to the west part of the city, with great involvement of people. It could be a good example of how to translate the example for collecting common memories.

Amsterdam Museum (formerly Amsterdam Historic Museum) has opened a new department: Amsterdam DNA. As a three-dimensional travel guide, this presentation takes you on a 45-minute historical tour of Amsterdam. Carefully selected highlights, including new exhibits and loan items, tell the interesting story of this multifaceted city in seven chapters. In each chapter, one exhibit forms the basis for the story of that period. These stories are told through exciting animations which are projected onto big glass screens in the middle of the gallery. Every visitor is given a travel guide which can activate the animations of each period in one of the ten languages offered, from Italian to Russian and Japanese.

At the end of the presentation, the results of the game reveal which characteristic you prefer and which city walk would interest you most. Specially to mark the launch of Amsterdam DNA, four walks through the city have been created for the mobile phone. This MuseumApp guides you through Amsterdam, past places linked to enterprise, free thinking, creativity or citizenship.

7. Museo del Prado, for Ipad and Appstore
https://www.museodelprado.es/en/apps/the-prado-guide

The Prado Guide in digital format is a practical, flexible and educational publication that allows users to enjoy the permanent collection of the Museo del Prado from anywhere in the world. One can take a tour by collection or by author. Users will enjoy the top quality of the images in high definition – four hundred works that accurately portray the essence of this emblematic museum – accompanied by specialised texts. With *The Prado Guide* app on the tablet, one is able to view fifty

masterpieces of the museum up close in detail and wander through the history of the art gallery and its leading figures.

The Prado Guide has been developed using publishing system DPS from Adobe. The first download of this software is provided free from the shop, and you can use it to see the options available for the editions in the various languages. Once you've selected your language, the guide costs you €5.99. It has been optimised for tablets larger than 7 inches.

8. Virtual experience at Illinois Holocaust Museum

https://www.ilholocaustmuseum.org/tas/

"What do we do when they're gone?" That's a question that's been asked frequently at the Illinois Holocaust Museum & Education Center; 72 years after the end of World War II, many Holocaust survivors are now passing away. And since encounters with survivors tend to be the most meaningful part of any visit to the museum, staff decided to find a way to preserve that legacy after these unique individuals are gone. Its centrepiece is the Abe & Ida Cooper Survivor Stories Experience, a chance for visitors to hear from real Holocaust survivors with the help of 3-D holographic technology. Thirteen Holocaust survivors–including seven from the Chicago area–worked with a team of film makers at the University of Southern California to record their memories. Interviewers catalogued the thousands of most-asked questions for Holocaust survivors, creating a truly interactive experience that is the first of its kind in the world. The facilitated experience allows visitors to ask questions–everything from "Do you have any pets?" to the more topical "What was it like in a concentration camp?"–and the survivor to respond in real time. If the question is too off-the-wall, the survivor will redirect the conversation, but Kelley Szany, director of education for the museum, says it doesn't happen very often.

9. Microsoft's new studios create Mixed Reality holograms

https://www.microsoft.com/en-us/mixed-reality/capture-studios

Microsoft is opening its first Mixed Reality capture studios in San Francisco and London, allowing developers and creators to create holograms from real life objects. Microsoft has been using its own studio at its Redmond headquarters to capture Buzz Aldrin, Reggie Watts, Max Frost, and Cirque Du Soleil performances and bring them into virtual reality and augmented reality holograms.

The new studios in San Francisco, London, and Redmond will allow third parties to create holograms that can be used on regular 2D screens, a HoloLens device, or even Microsoft's new Windows Mixed Reality (VR) headsets. Microsoft will be licensing these studios, and it's likely to be an expensive process to capture items as holograms.

Microsoft's new studios come just as the augmented reality wars between Microsoft, Google, Apple, and Facebook begin. Tech companies are trying to bring some type of AR experience mainstream, and a tight integration of hardware and software will be key to convince consumers that mixed reality computing is the next major shift beyond PCs, laptops, and smartphones.

10. ICON 360: Exclusive virtual reality video tour of The Dorchester

ICON 360: exclusive virtual reality video tour of The Goring

Filmed with a 360-degree camera, this footage allows you to explore the space in a number of ways. If you're watching on a desktop or laptop, you can change your viewpoint by placing the cursor

directly on the video to click and drag around each room. If, however, you are watching on a mobile phone or tablet, simply point the device in the direction you want to look. Should you have access to a virtual reality headset, you can watch the video in 3D for an even more immersive experience. Since its very earliest days, The Dorchester's heady combination of glamour and refinement has drawn prestigious guests from all over the world, from royalty and politicians to film stars, musicians and artists. Prince Philip celebrated his stag night here; Ernest Hemingway spent much of the Second World War in the hotel bar; and Alfred Hitchcock declared it the perfect spot for a murder, what with the body-burying potential presented by Hyde Park, just across the road.

11. VR Visit to the Holy Temple in Jerusalem
https://english.thekotel.org/western_wall_sites/a_look_into_the_past/

A controversial virtual-reality tour showing the Temple before its destruction is dazzling. But that doesn't mean the producers want it rebuilt. For the first time in Israel you can take a tour of the Second Temple using advanced virtual-reality technology. This 360-degree perspective lets you see the beauty of the Temple that was destroyed approximately 2,000 years ago.

During the visit, you will put on a special set of goggles that will take you back thousands of years in time and land you in the most important place for the Jewish nation: The Temple. The specially-designed seats will allow you to get a real sense of what the Temple was like in all its glory.

12. Atlas Obscura
https://www.atlasobscura.com/

Atlas Obscura has built its brand and business around its mission to help people discover the real world. Now it's experimenting with bringing that ethos to the virtual world as well. The site launched the first season of Atlas Obscura VR, a series of virtual reality videos that let viewers explore exotic locales such as the Temples of Damanhur in northern Italy, the Salt Mines of Salina Turda, Transylvania, and California's Winchester House of Mystery. The videos, designed for Samsung's Galaxy Gear VR and produced by production company Start VR, are designed around interactivity: Users can chose their own paths around the experiences, uncovering secrets and routes as they explore the virtual environments. The three primary locations are joined by a few dozen other places, which are explored via photos and audio.

The VR series is an experimental effort to extend the Atlas Obscura brand into a space that it would seem particularly well suited for. While the site has been talking about investing in VR for some time, it wasn't until Oculus approached StartVR that Atlas Obscura that it was able to make the push. Atlas Obscura, creators said, works best when "people actually go out in the world and have an experience, whether it's with us or by using the site to find something amazing." VR headsets, on the other hand, tend to remain indoors, and their use can come at the expense of users going outside.

Atlas Obscura has, however, largely squared away this cognitive dissonance. While the site's core mission is to encourage readers to see the world, many locations are difficult to travel to, dangerous (such as Brazil's aptly-named Snake Island), or closed to tourists. These kinds of places may turn out to be the perfect fit for Atlas Obscura's VR projects and an effective way for the site to experiment wit the tech while staying true to its mission.

13. Italian Soccer Giant Juventus Unveils Virtual Reality App

http://www.juventus.com/en/news/news/2017/juventus-vr-the-ground-breaking-bianconeri-app.php
https://play.google.com/store/apps/details?id=com.juventus.app.vr

Legendary Italian soccer club Juventus FC launched a virtual reality app Thursday with four episodes taking users onto the match-day pitch, behind the scenes at training and into the middle of its Serie A championship celebration last season. Juventus VR is the new official Juventus app that brings you closer to the action than ever before in virtual reality. Experience Juventus from the view point of your favourite heroes: soak in the Stadium atmosphere from the centre circle, step inside the home dressing room, go behind the scenes at Juventus Center, take a journey through Bianconeri history at J|Museum. Juventus VR brings the Juventus universe to you, from the comfort of your own home. Virtual reality has been gaining a foothold for sports performance training for years, through companies such as STRIVR and EON Reality, but is increasingly being used for the fan experience. Among other examples: Intel has broadcast Major League Baseball, NCAA tournament and PGA Tour events in VR; the Boston Red Sox, Detroit Tigers have installed VR batting cage experiences among other fan entertainment uses; and Facebook founder Mark Zuckerberg said Wednesday that his company was developing a VR app called Venues that lets users watch live sports and concerts in a shared environment. "It's another example of how VR is going to bring us closer together in ways that might not be possible in the physical world," Zuckerberg said. The Juventus app is initially available exclusively on Facebook-owned Oculus devices but will soon be made compatible for Google's Cardboard. In time, the club would produce and release more episodes.

14. Face-to-face with 'The Enemy'

http://theenemyishere.org/

Walking by the MIT Museum is intriguing— a quick peek through its Mass Ave windows shows patrons decked out in heavy goggles and backpacks meandering through a mostly empty space. They're participating in *The Enemy,* a virtual reality (VR) experience intended to inform people about perspectives of war.

Before entering the exhibit, one takes a survey that determines how it will be set up for him: the VR world of *The Enemy* contains three rooms which appear in a user-tailored order. Even the lighting in the virtual museum is determined by the survey answers and contributes to the interactive journalism.

Inside, visitors meet and interact with the holograms of six real fighters — one from each side — in three ongoing conflicts (those of Israel/Palestine, the Congo, and El Salvador). They hear back-and-forth interviews wherein they discuss their history with violence, their thoughts about enemies, and their simple hopes and fears in life. The experience is meant to encourage discussion on violence, humanizing the people involved in these conflicts.

The voice on the other side of the interviews is photojournalist Karim Ben Khelifa, who developed the project during his artist residency at MIT. Khelifa collaborated with MIT Professor Fox Harrell to bring his idea to life; beyond the VR exhibit, *The Enemy* exists in an augmented-reality smart phone application.

15. Second Canvas app – Prado Museum

https://www.museodelprado.es/en/apps/second-canvas-museo-del-prado

The app also includes about 60 related works, an explanatory sheet for each work, as well as audio guides and sign guides. This application, formerly called Second Canvas Museo del Prado, has been updated with a new design, an improved user experience and a smaller size to facilitate its installation in smartphones and tablets. Browse, learn, discover, thrill, teach and share the experience with your friends, family or classmates. The app Second Canvas Prado Museum - Masterpieces is a perfect tool for teachers who want to bring students to art through the essence and stories of great works.

Technologies - hardware and software(31 cases)

The ultimate and eventual hardware platform for augmented reality will be glasses and goggles. But until technology advances enough to enable that broadly, AR will live on smartphones and tablets.

The industry is focusing on mobile devices because they're ubiquitous and have the basic necessary hardware ingredients for AR - connectivity, screens, cameras, processors, motion sensors and the ability to run apps.

Everybody will be surprised when the obvious and inevitable happens - when the capabilities and performance of AR on phones and tablets becomes the reason to buy one brand of phone over another. You can bet that smartphone makers will then innovate with new hardware features to boost AR.

It's actually already happening. Silicon Valley is suddenly exploding with chatter about an industry-wide race to optimize smart phones for AR.

Here's what industry nerds are whispering about:

The iPhone laser - Apple is trying to build a rear-facing 3D laser system into the upcoming iPhone 8. It's also possible that the new component could be introduced in a later model. The purpose of the system - which involves a laser beam generator, lens and chip - is to quickly and accurately measure distance, not only for faster auto-focus for the camera (especially helpful in low light), but also for better placement of virtual objects in physical space with AR apps. More exacting information about surfaces and objects allows virtual material to appear to interact more accurately with the real world. And it will greatly enhance utility - for example, to enable quick measurements in industrial settings. This new hardware element is assumed to improve the accurate positioning of virtual objects inside apps built with Apple's ARKit over the current system, which is already very accurate.

The hologram phone - an Android smartphone in the first quarter of 2018 called [Hydrogen One](#). The phone's screen, called a "hydrogen holographic display," will be able to show 3D holographic content without special glasses. It uses "multi-view" or "4-view" display technology, instead of a 3D "2-view" approach. It will also be modular, with attachments that enable, among other things, the shooting of "holographic images." The phone will start at $1,195 unlocked and is currently available for pre-order.

The Surface phone and Huawei mystery - Microsoft is working on a Surface-branded Windows 10 device - phone, tablet (or phablet) - optimized for AR. He said that prototypes of the devices are already being passed around on the Microsoft campus. With the Hydrogen One, the Surface phone would be designed primarily for AR - a bet by Microsoft that AR itself will be a primary application. Huawei's upcoming Mate 10 smartphone also hint vaguely at AR-specific hardware, but it's unknown exactly what those components are or how they boost AR.

The smartphone makers are scrambling to beat each other to market with compelling advantages in AR.

A casual observer could be forgiven for assuming that Google is way ahead on the AR hardware front. After all, its **Tango system**, which Google first announced three years ago, seems to be ahead of the pack. Two devices - the Asustek ZenFone AR and the Lenovo Phab 2 Pro -- already support Tango. (The Tango system involves advanced hardware for rapidly mapping an indoor environment - ideal for AR applications.) The problem is that these phones represent an insignificant percentage of the Android market. As a result, Google's Tango-specific APIs are not widely used and Tango software is rare. With Moore's Law bringing down the cost of Tango's expensive hardware, that may change eventually. The best thing about Tango phones is that they provide a guidebook to the future of smartphones. Because of AR, smartphones will need special sensors and massive processing power.

Meanwhile, the biggest event ever to happen in the world of augmented reality is the announcement last month by Apple of its ARKit for building augmented reality apps for the upcoming iOS 11 platform. When the new iPhone and iPad software hits, developers will gain access to a billion theoretical users. AR on mobile devices will go mainstream fast, and smart phone buyers will start choosing phones based on AR capabilities (much like they now choose based on camera quality).

This prediction applies to enterprise employees in BYOD (bring-your-own-device) environments, too. Just as in-house apps and back-end systems developers can count on BYOD devices sporting camera electronics, they'll soon count on them to do advanced AR.

Today, most enterprise decision-makers assume AR applications will be served up on heads-up displays, special goggles and other futuristic hardware and that the AR is a challenge for the far-off future. It's time to adjust those assumptions.

With each passing day, it appears that enterprise AR will soon be deployed widely via smartphones and tablets, including BYOD electronics. This shift should and will affect buying decisions. AR favors phones and tablets, as well as rare laptop or hybrid devices with rear-facing cameras, such as the Microsoft Surface Book.

https://www.computerworld.com/article/3208047/virtual-reality/the-augmented-reality-boom-will-transform-phones.html

A third wave of devices employing augmented and virtual reality (AR and VR) define the two spectrums of immersive technology that could replace mobile computing.

A range of major products came to market in 2016 from companies including Oculus VR, Sony and Google. Since it bought Oculus for $2.1 billion, Facebook has acquired a further 11 AR/VR companies, underscoring the company's view that VR and AR will form the next frontier. The large investments and acquisitions by tech giants suggest that these technologies will become increasingly integrated with the platforms on which we consume content.

According to a recent estimate by Goldman Sachs, AR and VR are expected to grow into a $95 billion market by 2025. The strongest demand for the technologies currently comes from industries in the creative economy - specifically, gaming, live events, video entertainment and retail – but will find wider applications in industries as diverse as healthcare, education, the military and real estate over time.

AR is exciting but we don't have many ways to experience it. Google Glass was underwhelming, HoloLens has field of vision problems (and still hasn't launched in a consumer capacity), Snap has filters, Magic Leap is silent, and the rest of it is done on our phone, like *Pokemon Go* or Google's Project Tango. Plus, nobody has come close to building AR into glasses we would wear on a day-to-day basis. Like voice-controlled tech, AR has plenty of inspiration but no one will get on board and start really using it until it works every time, all the time and it looks good, too.

VR, on the other hand, is an experience that's a little easier to understand. You put on a headset and get transported to another world, with two of your senses cut off from reality, tricking your mind into thinking you're some place you're not. Now, the hardware isn't perfect just yet. There needs to be higher resolution displays, better latency, more immersive ways to feel your VR content and eye-tracking, which can be used to display better graphics and make AI characters in virtual worlds treat you like a person in the real world would.

What distinguishes VR from adjacent technologies is the level of immersion it promises. When VR users look around their view of that world adjusts the same way it would if they were looking or moving in *real* reality. The key buzzword here is presence, shorthand for technology and content that can trick the brain into believing it is somewhere it's not. When you flinch at a virtual dinosaur, or don't want to step off an imaginary ledge, that's presence at work. HTC Vive, Oculus Rift and Google Cardboard are examples of this type of immersion.

Augmented Reality (AR) takes your view of the real world and adds digital information and/or data on top of it. This might be as simple as numbers or text notifications, or as complex as a simulated screen. But in general, AR lets you see both synthetic light as well as natural light bouncing off objects in the real world. Pokemon Go is a game that fits this category based on the game's characters located at certain points on maps; however, the character, when found, is not tethered in that one spot as it moves around as your phone moves. Mixed Reality would give the object a "tethered" characteristic. Google Glass is the example of this type of augmentation.

Mixed Reality is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. Best known devide to be used for MR is Microsoft Hololens. Mixed reality takes place not only in the physical world or the virtual world, but is a mix of reality and virtual reality. It anchors those virtual objects to a point in real space, making it possible to treat them as "real," at least from the perspective of the person who can see the MR experience.

1. Google Cardboard

One of the quickest, inexpensive and versatile headware setups for diving into Virtual Reality. Use your phone as long as it's under 6" and download "Cardboard" from either google play or app store to start enjoying this tech.

2. Oculus Rift - Developer Kit 2

Oculus Rift is a unique interactive VR experience. It relies on a camera to pick up the LED points on the headset to gauge your movements. Interaction can be achieved through looking at a "hotspots" or by introducing mouse clicks. It has 1080p screens, a low persistence OLED, a redesigned SDK and optimized Unity and Unreal Engine 4 integrations. Oculus wants you to be prepared for your creative endeavour.

3. HTC Vive

Once you put on the Vive headset, you're immersed in a world full of surprises. Walk around freely and explore everything–the Chaperone guidance system keeps you within the bounds of your play area. Stunning graphics make it feel so real and surreal simultaneously.

4. Google Glass

Google Glass is a headset, or optical head-mounted display, that is worn like a pair of eyeglasses. It was developed with the mission of producing a ubiquitous computer. Google Glass displayed information in a smartphone-like hands-free format. Wearers communicated with the Internet via natural language voice commands.

b) Software

One can start with modelling software to create the desired things, and then move those things into a real-time engine to turn it into something you can experience in VR. These are going to be the tools if one wants to create purely digital environments, but also if we are making physical items to interface with your digital experiences.

Here is the overview of some of the software tools available:

Intelligent Hardware:

http://www.ecultobservatory.eu/basic-page/tech-module-44-intelligent-hardware

Wearable technology:

http://www.ecultobservatory.eu/basic-page/tech-module-46-wearable-technology

Software Tools, VR capable:

1. HTC development - VR integration The link will give you more information on integration for Unity3D, Unreal Engine 4, OpenVR (lower level access for third party 3D engines), Cryengine, Lumberyard, and MonkeyVR.

2. Oculus Rift development - VR integration The link will give you more information for Unity3D, Unreal Engine 4, CryEngine, Autodesk Stingray, MaxPlay, Amazon Lumberyard, and mobile SDK. Oculus SDK supports Windows 7 as well.

3. Google Cardboard development - VR integration For developing VR contents, use link to get more information for Unity3D, Unreal Engine 4, Android and IOS SDK documentation.

4. Sketchfab Want to join a community with over half a million creators contributing over a million models? Sketchfab is the world's largest platform to publish, share and discover 3D content online and in VR.

5. BlenderVR BlenderVR is an adaptation of the Blender Game Engine to support CAVE/VideoWall, Head-Mounted Display (HMD) and external rendering modality engines.

6. Gravity Sketch The software is intended to enable users to create quick 3D mockups of designs in VR space, using an HTC Vive or Oculus Rift headset, then export them to standard CAD or DCC applications. Gravity Sketch VR also imports and exports geometry in OBJ or STL format, making it possible to export models for 3D printing, or in order to refine them in other 3D applications.

7. VR-Plugin for Autodesk Maya Now you can directly see the 3D environment in Autodesk Maya in your HMD (Oculus Rift, HTC Vive). Cost associated. Make sure to have required software/hardware.

8. Yulio VR plugin for 3DS Max, SketchUp Whether you work in SketchUp, 3ds Max, Revit, or Rhino, their plugins convert your 3D renderings into immersive VR experiences. Cost associated. Make sure to have required software/hardware.

Real-time engines

1. Unreal Engine – Cost: Free

The Unreal Engine is very well known in the games industry. This package is incredibly versatile, allowing for creation of games from 2d hand drawn looking platformers up to cinematic almost movie like experiences. They've charged into virtual reality head-on and support the latest technologies natively. There is a built in marketplace where you can find and purchase assets to include in your projects and a very large community sharing tutorials and inspiration. Most

impressively, the Unreal Engine is absolutely free. You can download it now and get started creating virtual reality experiences with zero cost. Video: https://youtu.be/l88n8a4Yphw

2. Unity 3D – Cost: Free

Over the last several years, Unity has grown from a plucky little startup to go toe to toe with the likes of the Unreal Engine. The upcoming release of the first major commercially available VR headsets has only helped level the playing field as Unity has been aggressively courting this community. You can download Unity and begin building VR environments immediately with no prior experience.

https://youtu.be/8lWpnvNxs8k

3. Cryengine – cost: Pay what you want

The Cryengine has long been known for its rich visual abilities, the flagship games from this engine often being used as benchmarks to determine a computer's strength. Up till very recently, there were costs associated with this engine that kept it from the hands of many small developers. Now, it is a pay-what-you-want model which means you could download it for free just to try it out and see if you like it.

https://youtu.be/wcnrt1pX5XA

4. Lumberyard – cost: Free

Lumberyard was recently unveiled by Amazon. This is a recent addition to the market, and the community is just beginning to grow. On the technical side, this is a previous version of the crytech engine, but with Amazon backing it, some tweaks have been made.

https://youtu.be/EdU1s1FGTDY

Modeling software

All of the items that are in virtual worlds have to be created. To build these things, one must model them in 3d modeling software. There are many, many, software available.

1. Blender – Cost: Free

Blender is an open source, cross platform modelling animation and rendering tool. It has grown to be incredibly robust and powerful, rivalling the industry names like Maya, Softimage, and 3DS max. The feature set included with the absolutely free product is enough to take you through the entire production pipeline of game creation. It even has its own built-in game engine, though VR support is still not as strong as you'll see in the real-time engines above.
There is a massive community behind this package and you can find tons of tutorials all over the web. Video: https://youtu.be/Cpg_TvWzU2E

2. Sculptris – Cost: Free

On the other end of the spectrum is Sculptris. This free software is very limited in functionality, but does its singular task quite well. If you find yourself encumbered by the interface of a typical modeling software, give this a try. The interface mimics sculpting a piece of clay, and it feels very natural. Video: https://youtu.be/KrViiOLTWTM

Those are just two examples on opposite ends of the feature spectrum. Here are a few more pieces of software to try out: [Sketchup Make, Wings 3d, Equinox 3d, Daz studio, 3D crafter](#)

Image manipulation for textures and more Of course modelling isn't the only tool we need. For 3D modeling we are also going to have to do some basic image manipulation. We can't all afford photoshop, so there are many free pieces of software that can easily do the job.

3. Gimp – cost: Free
Gimp, or GNU Image Manipulation Program is a very powerful tool for image manipulation. Users jumping directly from photoshop may get frustrated with workflow and interface differences, but make no mistake, this package can get the job done. If you are doing backgrounds, UI elements, textures, or anything else, GIMP can handle it. It is cross platform too, which is nice.

4. Paint.net – cost:Free

Paint.net may not be as extensively powerful as GIMP, but for some people the interface is easier to understand.

What about sound?
For those just getting started, many canned effects will likely keep us busy. However, if we want to make our own sound effects and musical cues, we're going to have to be able to edit.

1. Audacity – cost: free
There are a ton of ways that you can use Audacity. The most common uses for a beginner would be to record a sound, and bring it into Audacity to clean it up and tweak the speed and pitch. From there, you can expand into the many, many features of the software. http://www.audacityteam.org

2. OcenAudio – cost:free
Not quite as feature dense as Audacity, you may find the interface a bit easier to navigate. http://www.ocenaudio.com/

Code programming software

1. Visual Studio Community – cost:free
This was called visual studio express, and was released to get more people coding, who couldn't afford the full package. The community version is free and is extremely capable. There are many useful tools and a vibrant ecosystem with tons of documentation.

https://www.visualstudio.com/vs/community/

2. Notepad++ - cost:free
Notepad++ can be used for all kinds of code, mainly php/html/css. However, it is extremely robust in that one can jump right into C++ or C# or whatever game engine you want. It is totally free, robust, and uncluttered. It is not the easiest though.

https://notepad-plus-plus.org/

Commercial products:

1. Vizard Virtual Reality Software

http://www.worldviz.com/vizard-virtual-reality-software/

Create engaging virtual worlds and immersive applications with the most comprehensive virtual reality development platform in the industry.

Bad practices cases regarding the use of technologies in museums:

1. The House of European History, Brussels (opened May 2017)

https://historia-europa.ep.eu/home

The brand new museum about the history of Europe (well, 19th to 20th century history) is housed in a wonderfully renovated building of the 1930. The exhibition area – 6 floors for the permanent exhibition – is spacious and wonderful. But the user experience is somewhat limited: All users get a tablet that provides information in all 24 languages of the EU. While this is commendable, there are some flaws: You get the tablet for free but only if you have an identity card, passport or drivers licence. Any other document (e.g. press card) is not accepted. Therefore, no tablet, no information. Because there is no text panel whatsoever to explain anything. Also no QR code or similar are provided to connect with a mobile. This limitations are unfortunate for a newly built museum. Visitors are forced to take a tablet which makes the 6 floor circuit somewhat bothersome. You need to handle the tablet with two hands – which is not easy when walking around. OK, there are lockers to leave one's handbag, but still. I saw elderly people struggling with it. Young kids, on the other hand, play more with the tablet than looking at the exhibits…so for any age class, it seems not an ideal solution. Given that the whole project costed 20+ MEUR (not counting the 32 MEUR for the renovation of the building), the result, from a mere user experience point of view, is disappointing. When engaging in the use of new technologies, more than one option should be considered. To "force" a device on visitors (and not giving any other option) is not good practice, it is rather (very) bad practice.

2. 3D V&A Museum: too minimalistic. It would be nice to have more objects and improved quality, as the idea to handle objects that otherwise you cannot touch or handle is intriguing.

3. Colour the temple: a bit like the CHESS app where you can see antique Greek statues of the acropolis museum in colour (as they originally were). A nice idea but a bit limited in my view.

4. Weltate: VR Operas: Again, this may be a funny idea to bring opera nearer to people but again, the heavy (?) headset may not be ideal. Looks still a bit clumsy.

5. Museum "Stupor Mundi" Iesi: Only VR in a real museum; not high tech but rather old-fashioned tech (films, animated figures from books; few VR).

6. Virtual Pompei: we are not sure that running around with heavy (?) headgear is fun and a good user experience.

WG 2.1 – Tech & Tools - SWOT Analysis

Strengths	Weakness
• you don't need to be on-line • you can visit it any time any place • stop-continue-pause your experience • updatable by a curator or a museum • cost-effective • people are not blocking the view (e.g. the Mona Lisa) • not complex • contribute, comment • sharing • providing additional information • updatable • interaction • show more then you have on display • providing additional information	• fake • no tactile feedback • maintainance • shelf life • overkill of content
Opportunities	**Threats**
• sponsors • user analysis • improvement, what's next	• distraction of technology • privacy threats • distraction • overkill **Challenges** • user-friendlines (impaired people) • together – alone • atttention span • storytelling • user interface and interaction

	design
	● how to stand out
	● how to stay an authority as a museum
	● comment contribution

Some basic attributes of a museum were identified as:

- Access to the whole collection without limitations + the knowledges of the collection

- Openminded

- Working together

- Being creative in finding resources and funding

Conclusion

Virtual reality (VR) is on the verge of mainstream adoption, while augmented reality (AR) experiences have already begun to enter the public consciousness. What began as a niche is finally accelerating in its journey towards popular use. From film studios and games developers to global brands and advertising agencies, developers are creating more and more sophisticated, immersive experiences to captivate and emotionally engage audiences. In its latest global forecast, the predictions for sales of dedicated VR headsets will grow to 22 million by 2021 – an 800 percent increase versus 2017. The same report claims sales of smartphone headsets, such as Samsung's Gear VR, will grow five-fold to 70 million during the same period. Despite the success of 360-degree video content to date, the entertainment industry has encountered numerous problems in achieving true immersion within those experiences. The Holy Grail in VR is to create a true sense of presence by making the viewer believe, even for a split second, they're truly inside the virtual world. But that's easier said than done and, while every technological advancement brings us a step closer, there remain a number of hurdles to overcome. Most VR experiences are designed to be viewed on a headset strapped around your eyes like goggles. Stereoscopic 360 video adds depth in a similar way to stereo 3D movies but, while the experience is compelling, the depth is only on the horizon and the illusion breaks as soon as you start to shift your head - the world moves with your head, rather than your head moving within the world. This is one of the reasons VR in particular has a reputation for making people feel sick. Solving the limitations of 360 video is the development of volumetric video and positional VR. Companies like Lytro – with its light-field Immerge camera – are carving a new path in immersive content. The Immerge camera records the depth and distance of objects in an environment. Then, rather than stitching images together like a traditional 360-degree camera, it effectively recreates the scene in a 3D virtual space.By capturing information on all light passing into the camera sensor, it's possible to move around inside a scene, even looking under or behind objects, creating a true sense of presence. This has been termed 'six degrees of freedom' in VR circles. The experience is also impacted by the current field of view (FOV) offered by first- and second-generation headsets. Our binocular vision makes the human FOV around 200° horizontally, but most headsets give a measly 110° – just over half of what we see in reality. We're also still a long way off creating experiences of as high a resolution as we see with the human eye; it's immediately evident we're watching via a screen and is therefore difficult to persuade the user that the action is unfolding in front of their very eyes.

Latency, too, can undo the illusion. Even the tiniest delay in the display reacting to a movement or command dissolves any sense of reality. To achieve full immersion, headsets need to drastically improve across FOV, resolution and latency. Foveated rendering is another emerging technology making waves in VR. The image rendering technique, which mimics the way humans focus on and process the world around them, uses gaze detection to tell the VR application where the user is looking and therefore which area of the view to construct in high definition. Just as the human eye only focuses on a small window of the world around us at any one time, foveated rendering draws the rest of our FOV at lower resolutions. As well as saving an enormous amount of pixel data, the technology better replicates how we truly see the world, creating a deeper, more immersive experience. We have a way to go before we reach true immersion in VR and AR content, with

major developments in both software and hardware still to be made. The push towards non-linear, adaptive experiences is an exciting one, but it will all be undone if a slight movement of the head means the illusion is broken – or indeed if we all end up feeling sick halfway through.

That we need hardware at all is a barrier in itself. After all, how immersed can you really feel if you've got a headset strapped to your face or are holding a controller in your hands? Perhaps somewhere down the line we'll have an ocular implant, or maybe we'll just see the arrival of something a little less ugly than Google Glass that people are more willing to wear. Advancements in hardware and software need to go hand-in-hand if we're to create a real sense of presence, and progress will likely be made in waves as a number of intertwined breakthroughs create a chain reaction that propels us forwards. We're certainly on the road to something special, and it's undoubtedly a fascinating time to be at the heart of the visual effects industry. There will always be a place for the classic linear story because delivering an experience that is compelling for the agent is ultimately subjective. The big screen has thus far proven effective in immersing audiences because sometimes we do just want to sit back, relinquish control and be taken on a journey that isn't our own. But we're heading towards 'hyper' reality and, eventually, we'll drop the AR and VR monikers altogether as the technologies begin to intertwine. We'll also lose the clunky headsets and the need to plug into a powerful, static computer, as the switch between the virtual and the real world becomes easier and quicker, and ultimately more immersive.