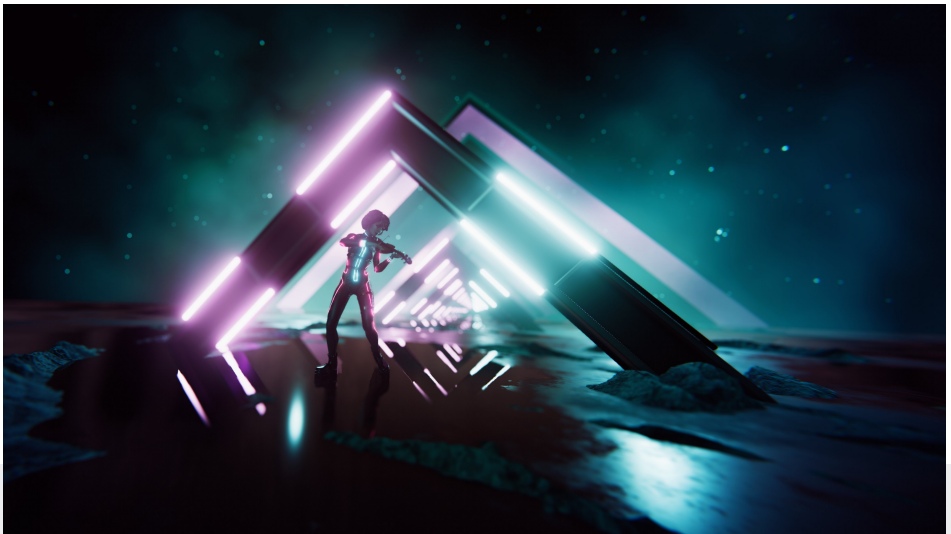


# Immersive Tourism

State of the Art of Immersive Tourism  
Realities through XR Technology

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DISCOVER YOUR WORLD



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Front page image credit: Lindsey Sterling performing in WaveXR

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# Disrupted Tourism Experiences

The core product of tourism is the creation of engaging and increasingly immersive experiences which can transform tourists into a better 'version' of themselves by educating and developing attitudes and values. The core idea of travel and tourism dates to Aristotle's constructivist approach that knowledge can only be gained from interacting with the world (Hein, 2018).

Since early 2020, many parts of the world have made a leap into virtuality. A large proportion of the workforce has migrated to a digital environment, growing the popularity of online communication tools such as Zoom (from 10 million to 300 million users since the start of COVID-19), Microsoft Teams, Skype, and even more so due to rapid developments in Augmented, Virtual and Mixed realities and the possibilities to (re)create and enrich tourism attractions through digital means ranging from scanning, recording and software applications. The pandemic has not only affected the way we work within the tourism domain but has had a profound impact on the way we travel, create tourist experience, and engage with stakeholders. The impact on tourism in Europe is expected to be even greater than in the rest of the world as around half of all the world's tourists visit Europe, resulting in devastating consequences for the industry.

Several researchers and tourism experts have argued that this crisis could prove to be a blessing in disguise to allow destination management organisations (DMOs) to invest into digital content and strategies (e.g. Chirisa et al., 2020). According to a recent article in the German newspaper *Deutschewelle* (Kirchhoff, 2020), most German destinations

do not yet utilise the crisis as a chance to develop their often long-outdated digital profile and visual content. Existing links refer to deserted YouTube Channels, webcams, television documentaries, photos to be used as screensaver or offline brochures. However, there surely are other ways to digital (re)connect and engage with tourists remotely and our desire to dream about the next journey. Such as Lonely Planet having travel-from-home tourists tuning in on Spotify playlists such as 'Hear the music, explore the USA' exploring storytelling and local music ([www.visittheusa.com/music](http://www.visittheusa.com/music)).

While a lot of the technology is often readily available to be implemented and used, there is no one-size-fits-all solution. Instead, in-depth understanding of the possibilities, choices to make and context-fit is necessary to reap the fruits of investments and achieve the desired objective. This is a fitting time to explore virtual solutions that allow DMOs to shape a technological fit to continue telling the stories of their destinations and enable tourists to keep dreaming and experiencing.

## Travel starts in your mind

Traveling in our imagination has already been an alternative to physical visits, ever since one of the first backpacker novels from Joseph von Eichendorff, 'Memoirs of a Good-for-Nothing' has been published in 1826. Yearnings of exploring destinations, in times when we are limited to no more than dreaming about our next vacation, we look for alternatives to calm our 'Fernweh' (yearning to see far-flung places) or 'Wanderlust' (desire to wander).

Virtual Tourism offers a solution to some of these desires with the intention to present a digital teaser that motivates a future journey. While for many, the current technological state will not by far replace real travel experiences, they provide us with a glance of what could very soon become a supplementing form of travelling. Investments into creating spectacular 360-degree images, videos, stories, and virtual tours are increasing, while Rogers (2020) argued that Virtual Reality (VR) videos will become the ultimate tool for travel advisors and meeting and incentive planners to create a 'try-before-you-buy' experience to dramatically increase sales volumes. This choice for investment is often difficult to make particularly for businesses operating in the tourism industry, as dealing with intangible products and a range of uncontrollable factors in the environment can greatly influence the tourist experience. Nonetheless, large amounts of research and investments have been granted particularly for exploring possibilities of emerging technologies that are able to shape, redesign and enhance the experience of tourists at different stages of the tourist journey. Recently, an increasing body of knowledge (detailed below) has been generated predominantly around the potential use of virtual reality (VR), augmented reality (AR) and mixed reality (MR) as well as the gamification and



storification of content to create more engaging, interactive, and immersive encounters that are able to create memorable and meaningful tourist experiences. As Extended Reality (XR) technologies continue to develop, it is expected to be more seamlessly integrated into the tourism journey, enhancing tourists' interaction before, during and after the trip. The immersive nature of XR technologies offers a technological solution that can sustainably influence our reality and living in areas such as economy, research, art, culture, and entertainment to tackle critical issue such as over-tourism and water pollution in Venice's canals, or the carbon footprint in the Indian Himalayas and areas of China that have long been suffering from unhealthy smog levels (Chen, 2020).

Previous use cases and studies have shown that the successful development and implementation of technology is highly context-dependent, and it remains a challenge to design interactions that are beneficial to tourists, businesses as well as other stakeholders alike. The purpose of this whitepaper is to guide you through the possibilities, considerations, and challenges of the current state of immersive tourism experiences. Through outlining current developments in tourism and technological advances, a key focus will be placed on the use of virtual, augmented, and mixed reality technologies to enhance tourist experiences. A selection of use cases will be introduced to demonstrate how VR, AR, and MR enhance specific points throughout the tourist journey.

# Understanding the XR Realms

## Extended Realities (XR) Explained

In the current state of XR, we largely distinguish between three types of reality enhancements: virtual reality (VR), augmented reality (AR) and mixed reality (MR). The XR market was said to be growing exponentially before the pandemic with an expected revenue of \$65 billion by 2024 (Merel, 2020), while around two thirds of the revenue being generated by VR. The constant growth potential is fuelled by a continuously dropping consumer price level and increasing quality of content availability. Added benefits in forms of improved content, accessibility, and ease of use as well as developments in the digital infrastructure through a new generation 5G network technology is expected to further accelerate adoption and commercialization of XR. In addition, the VR/AR Association (2020) revealed that the need to overcome isolation and loneliness has significantly increased this year with social virtual reality speeding up consumer adaption of the technology (VR/AR Association, 2020).

## Virtual Reality (VR)

VR is largely understood as the complete **computer-generated imagery** (CGI) environment that is typically accessed through wearable VR headsets. The goal is to fully immerse the user into a computer-simulated environment, by engaging as many senses as possible simultaneously and is therefore often referred to as 'immersive multimedia'. This implies that the virtual environment is not connected nor interacts with the immediate real environment, but rather *replaces* the user's physical world temporarily.

The VR consumer market has propelled itself particularly in the areas of gaming and entertainment. Up to recent years, it largely required the use of tethered devices (PC-connected) to allow for sufficient processing capacity. However, untethered (standalone) headsets such as the Oculus Go have started to emerge, making VR more practical and mobile.

Another type of VR is referred to as **Real World or 360 VR (videos)**, which focuses on real world images and is a largely popular form due to its low price point. While the user cannot directly interact with elements within the video, it is possible to control the viewing direction allowing for a perspective of *presence* through the VR device. Due to the limited interaction



CYCLE ALONG A COMPUTER-GENERATED DUTCH NEIGHBOURHOOD

required, comparatively inexpensive devices such as Samsung GearVR or Google Cardboard are sufficient to operate with the mere processing power of a smartphone.

## Augmented Reality (AR)

AR refers to the enhanced real-world vision through overlay of computer-generated content. While typically AR is largely known as visual augmentations, this can also relate to auditory or olfactory augmentations that are not originally part of the real environment. For visual overlays, current mobile AR applications utilize the device camera to overlay computer-generated information onto the camera vision of the device. Being a software-driven solution, AR overlays have so far largely been marker-based, or GPS-based.

More recent introduction of ARKit (iOS), ARCore (Android) for mobile devices or the open ARCloud ([openarcloud.org](https://openarcloud.org)) have further catapulted AR's usability. By allowing object recognition and calculating lighting conditions instantly, it augments computer-generated content more seamlessly into the real environment. The road to wearable AR HMDs is on the rise, with attempts by devices such as Google Glass or Vuzix Blade, being largely available as industrial and developer versions. Popular applications such as Facebook, Snapchat, Instagram and TikTok have additionally given AR a huge technology push through augmented filters, as the current pandemic situation has accelerated the demand for digital connectivity and facilitation even more.

Recent developments are aimed at reducing the hassle and project digital overlays on the real environment with AR lenses. Latest example is the Mojo Vision lens providing timely and location-based information without interrupting the context.



© mojo.vision

### Mixed Reality (MR)

AR's younger and more sophisticated brother. A key difference of AR to MR is the method of augmentation. While AR content is not directly interacting with or part of the real environment, but understood as an environment *overlay*, the purpose of MR is to overlay computer-generated content that is able to *merge* with the real environment and therefore requires responding capabilities to the supplemented context.

MR merges the real world with the virtually generated content into creating a third viewing dimension, where both realities can interact with each other in real time. MR goes beyond visual displays but incorporates spatial sound, environmental input such as locations and positioning (head tracking) in real and virtual space.

One of the early lessons is that there are different types of mixed realities. Devices such as the HoloLens and Magic Leap are built on holographic devices. They work with translucent glasses to allow users to see their immediate environment and create the effect of holograms in the user's peripheral vision. Other MR devices such as Windows MR headsets work with a similar notion as in VR to completely immerse the user in a computer-generated environment. However, device cameras are used to track the real environment and provide video graphics to the user's vision that reflect the immediate surrounding.

WATCH THE VIDEO TO LEARN  
MORE ABOUT MIXED REALITY



## Immersive Tourism



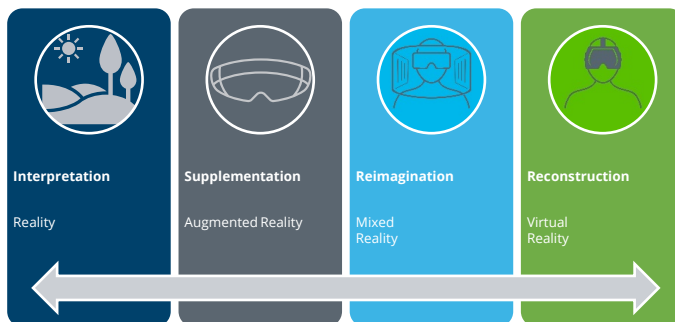
HoloLens Machu Picchu © hololens.reality.news

Our desire to experience new cultures, faraway places or neighbouring galleries has not diminished amid the lockdown. As human beings, we are seeking for connection with each other, other cultures, and nature. Turning towards virtual content might be a temporary escape into another world, which still feels awkward, exciting, and new, but embracing online resources with webcams, 360 videos, mobile devices or VR platforms turns into the new normal.

Immersive Tourism replicates the feeling of exploring the physical world in the virtual realm in form of mental travels. It might still be early days, but we can already see how the technology is starting to take form in the travel industry. Not only big travel agencies and companies like KLM and the TUI Group are looking into how to immerse (wanna-be) travellers into virtual content, but also global content providers such as the BBC's Natural History partnering up with tech companies Magic Leap to produce 360 and 3D videos of our planet's most astonishing nature. One of the first demos on the HoloLens already presented travel experiences of Machu Picchu and time traveling to ancient Rome back in 2015 and with people to be encouraged to travel less, the developments will continue to accelerate.

With immersive technologies on the rise, virtual travel is of interest for many travel providers and content creators. Technology does not only become cheaper, but more advanced with destinations and museums already producing digital twins of the real world by rendering top tourism sites such as the Louvre or preserving cultural heritage as virtual models (e.g., Mount St Michel). XR has seen tremendous growth in the last years due to hardware launches and new technology pushing into the market.

There are four methods to integrate technology into the tourist experience, which range from a basic supplementation of the real world to the level where technology itself is the core experience, transforming or reconstructing the tourist experience through technology. Based on that idea and Milgram and Kishino's (1994) Mixed Reality Continuum, we can state that the



Immersive Tourism Reality Continuum

Weber & Han, 2021

*Reality* may be staged or **interpreted** using conventional tools or technologies to enrich the experience. This is still the majority of tourist experiences, not letting much room for active involvement or co-creation.



*Augmented Reality* moves further into the realm of virtuality, using virtual annotations to **supplement** and possibly reinterpret the real world for navigation, entertainment, or marketing purposes. This allows that the virtual content interacts with the real environment.

Enhancing the tourist experience with *Mixed Reality* helps us enter the third viewing dimensions which open new frontiers to **reimagine** our world around us in ways only limited by our own imagination. These can represent the real world as much as possible or enrich them with possibilities that go beyond the reality representation.

*Virtual Reality* experiences typically refer to virtual tours that provide a feeling of presence and being in the real destination. Existing use cases have demonstrated the ability to completely **reconstruct** physical tourist experiences in the virtual world

WATCH NEWEST DEVELOPMENTS  
WITH UNREAL AND CESIUM



offering avenues to replace some physical components within the tourist experience (digital twins). Thanks to latest photogrammetry, high-resolution 3D scans of physical objects and people and virtual reconstructions of the real world are becoming more immersive and photorealistic.

# Use Cases of Immersive Tourism

## Re-Interpretation of Reality



© visitfaroeislands.com

Certainly, there are conventional ways to mediate the places we travel to, such as travel books or audio guides. A new and innovative way was launched by Faroe Islands with their **Remote Tourism campaign**, which unites virtual tourism experiences with game controllers to remotely walk around a destination. With a remote tourism tool, the first of its kind via a mobile device or PC, visitors can virtually explore Faroes' rugged mountains, cascading waterfalls, or traditional grass-roofed houses by interacting with locals. A local guide is equipped with a live video camera, allowing the virtual visitor not only to see views from an on-the-spot perspective, but interact and control where and how they explore the site using a joystick to walk, run or jump, as commonly used in computer games.

During the daily one-hour virtual broadcast, visitors can remotely control the moves of the guide for one minute not only by foot but skies, helicopter, or boat, giving a virtual bird's eye perspective of the island's wild and natural countryside.

Remote tourists steer the physical walker on the island using game controllers and live audio explanations which elevated these immersive walks to another level.

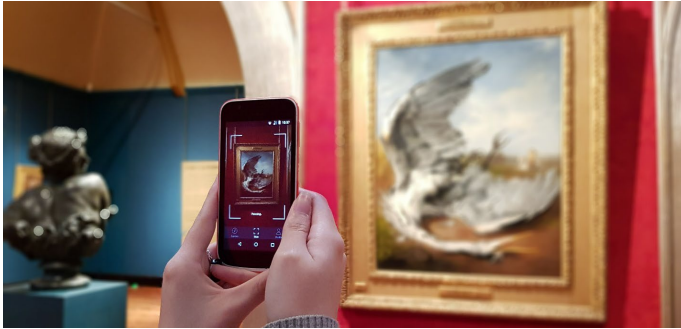
The experience stands out as it provides the locked-down tourist autonomy and excitement. The interaction and co-creation between remote tourists and local guides in a fun and new way is one of the success elements according to the DMO. During April to June 2020, Faroe Island has facilitated 22 online tours with around 700,000 remote tourists.

THE AIM OF **REMOTE TOURISM** WAS TO BRING JOY AND INSPIRATION DURING CHALLENGING TIMES, AND TO INSPIRE PEOPLE TO VISIT THE FAROE ISLANDS ONCE THIS WAS POSSIBLE AGAIN.

LEVI HANSSEN  
CONTENT & COMMUNICATIONS

## Supplementation through Augmented Reality

### Augmented Museum Experiences



©Watts Gallery & Smartify

Advancements in technology and accessibility for consumers and artists expand the world of art also digitally. Galleries and auction houses have developed augmented reality features for their apps for customers to superimpose art objects in one's own home before deciding to buy, or augment objects with additional information, e.g., **Smartify**.

Smartify is an AR app working with image recognition and artificial intelligence to enable users to access background information on specific objects. Within a single platform art can be discovered without downloading an app for each museum or having to rent different museum specific devices. The app is 'CORONA-proofed' and available for home in times the museum is closed.

In the app, the user holds up the device and scans the art piece using the device camera. Information is loaded from the museum data base or open-source data about the artist to uncover related unexhibited materials including videos, letters, sketches or rare images, and inspirational stories

behind the object. More advanced AR animation can be found in the Ray Harryhausen exhibition, showcasing an animated stop-motion AR skeleton from the Clash of the Titans, which was exclusively tailored to this exhibition and difficult to scale to other applications. Examples such as Smartify offer an opportunity for museums to rejuvenate their target group offering new ways of art experiences. The start-up is also looking ahead of the first-awe experience and exploring different business models together with museums as new revenue stream with an e-shop. The platform allows users to purchase prints, gifts, and souvenirs from their smartphone, with potential to boost financial, reputational, and service value of museums post-Covid. Historically e-commerce has been slowly embraced by museums with only 7% of total sales ([www.storyfutures.com](http://www.storyfutures.com)).

## Augmented Historic Trails



©Foundation Crossroads Brabant

**Brabant Remembers**, a project funded by the Dutch DMO Visit Brabant developed an engaging mobile AR experience that integrates storytelling to emotionally engage tourists on a historic trail evolving around the impact of the Second World War in the Province of Brabant, the Netherlands. The mobile based AR application, developed among others by Dutch Rose Media with help of BUAs, tells the personal stories of 75 people in 75 different locations across the country that tourists can access on location to uncover unusual, personal, and inspiring stories where life choices had to be made (Bijsterveld et al., 2019). Compared to common AR applications that provide additional augmented information, Brabant Remembers transformed the information to personal stories allowing tourists to empathize with the dilemma faced by people from the past and invites them to predict the choices made in the storyline. As such, it not only uses emotionally engaging content, but further aims for tourist engagement with the content at hand through location-based AR and volumetric captured humans.

### Contact:

[www.brabantremembers.com](http://www.brabantremembers.com)

## Augmented Food Experiences



© kabaq.io

In the food space, **QReal** (formerly Kabaq.io) is one of the early players of 3D lifelike food visualization and augmentation, which was since presented in multiple collaborative studies showing how food in AR could increase customer expenditure, and positive word of mouth. Currently visualized through handheld mobile devices, customers can select and visualize menu items and dishes and get a realistic perception of what the dish looks like. The level of detail in the augmented object allows customers to zoom in and out and rotate the item to take various perspectives and angles. Such object visualization is not only interesting to increase product choice and spending but is also a useful tool to reduce food waste by assisting customers to get a realistic impression of the amount of food that is being ordered. Specialized in 3D modelling in AR, its functions are now available via social media channels, QR codes, delivery apps and through catering menus.

**Contact:**

[www.qreal.io](http://www.qreal.io)

## Augmented Data Visualization



Tourism from an immersive branding strategy perspective. DPG Media together with MarketResponse launched an online brand segmentation tool based on large scale research. The brand model uses several brand values divided over different axes. Tourism organizations can compare their brand with competitor and media brands on several brand values. The data presented is hard to visualize in a 2D model. BUAs re-created the BSR Quality Planner as a hologram: the world's first brand segmentation model in AR. Research showed the added value of the AR model as media planners and brand strategist were able to make clearer and better decisions around tourism brand strategies using the AR model as opposed to the 2D representation.

### Contact:

[www.dpgmedia.nl/marketingadvies/thema/insights/artikel/bsr-quality-planner](http://www.dpgmedia.nl/marketingadvies/thema/insights/artikel/bsr-quality-planner)



## Re-imagination through Mixed Reality

### Re-imagined Theatre Experience



The history of Hendrik Ibsen's 'Peer Gynt' ©lillehammer.com

The outdoor theatre experience of **Peer Gynt**, Norway's most famous folk tale by Hendrik Ibsen at Gålå in the Gudbrandsdalen valley is an example of re-imagining the physical world through a digital frame. The tale is typically being told in form of a theatre play, digital and location-based game, and a walking trail and attracts yearly 19,000 guests (Visit Lillehammer, 2020). However, 2020 was the first time the play was cancelled due to COVID-19 measures, and the county of Innlandet (Norway) set a priority on digital realities improving policies and digital reality implementations in the local tourism ecosystem.

The audience engages in a digital dialogue with a *Peer Gynt* hologram as a teaser for the summer production. A fragment of the theatre performance was specially produced for the Mixed Reality DeepFrame ([www.realfiction.com/solutions/deepframe](http://www.realfiction.com/solutions/deepframe)) display that merges the real with the virtual world. The virtual

performance of the Peer Gynt play seemingly blend into the physical theatre stage in real-time. The audience simply looks through the display lens which was installed during the summer months 2020 at the theatre stage. The display provides a more social experience, as the audience views jointly the lifelike animations at any distance, without any isolating technology such as a traditional VR eyewear.

**Contact:**

en.lillehammer.com



PEER GYNT MIXED REALITY  
PRODUCTION

## Re-imagined Food Experiences



© DinnerInmotion

Arguably one of the most popular ways to engage all the senses in an immersive dining setting that involves the use of 3D projection mapping in the restaurant environment. **DinnerInMotion** located in Eindhoven, the Netherlands, and 3D mixed reality augmentations created by *Skullmapping* are just two of ample examples that have created immersive audio-visual culinary settings. Using multiple projectors and speakers in the immediate environment that seamlessly blend in with physical objects (e.g., tableware) offers an entertainment value for restaurant guests while waiting for their order to be prepared or consuming a dish through multi-sensory stimuli. Due to its storytelling capabilities, it is typically offered as culinary experience through multiple courses. Due to its popularity, 'Le Petit Chef' by *Skullmapping* has since been developed into additional storylines in collaboration with restaurants, bars and cruise lines and can be experienced at different times at selected restaurants throughout Europe. Immersive entertainment projections have since been extended by others, aiming to create immersive restaurant experiences through storytelling.

### Contact:

[www.dinnerinmotion.nl](http://www.dinnerinmotion.nl)

## Reconstructed through Virtual Reality

### Immersive Meetings & Worlds



© Facebook and Oculus ([www.oculus.com/facebookhorizon](http://www.oculus.com/facebookhorizon))

Global business travel can be expected to reduce massively when corporate travellers virtually join meetings and conferences in AR or VR. Companies realised quickly during the pandemic that online and video conferences are new drivers for XR technologies (VR/AR Association, 2020). While classical video conferences via Zoom or MS Teams may lack a communicative and spatial component, spontaneous connections, or serendipity in the hallway, online game-like environments and virtual conference tools take over the function of public spaces, cafés, and sports facilities.

After heavily investing in VR, Facebook is beta-testing **Horizon**, its new social virtual reality network on Oculus Quest and Rift platform planned to be launched in 2021 (Oculus Blog, 2020). As opposed to the business character of other virtual world platforms, Horizon is meant to become a space to hang out with friends, play games, watch movies, or learn new skills. Within the ever-expanding universe and interconnected

worlds, users can explore new places, build communities and create own places and experiences with people using the World Builder, a collection of easy-to-use creator tools without coding experience (Oculus Blog, 2020). With the cartoonish avatars, users can teleport between different game worlds of adventure and exploration (Hutchinson, 2020).

## Immersive Concert Experiences



© David Ortmann, taz ([taz.de/Virtuelles-Theater-in-Augsburg/!5685736/](https://taz.de/Virtuelles-Theater-in-Augsburg/!5685736/))

Some opera or classical music houses initiated live broadcasts in cinemas worldwide for almost a decade to reach a younger audience. However, screened performances lack the sense of co-presence and immersion with the audience, producing a boundary between performer and viewer. Using VR, the spectator transforms from a conventional passive role into a co-creative, participative position by taking on the point of view of a dancer for instance. The spectator takes on the role of an embodied shadow artist performing in the play or dance and thus has a first-hand, immediate spatial experience on stage. This change of perspective provides a huge value, as VR is providing an opportunity to slip into the role and perspective of others.

VR HAS A CLOSENESS  
AND AN IMMEDIACY  
THAT OTHERWISE  
CANNOT BE ACHIEVED.

ANDRÉ BÜCKER  
THEATRE DIRECTOR AUGSBURG

The **Staatstheater Augsburg** (Germany) shipped 500 VR headsets (Oculus Quest/Go, Vive) to their audience homes within Augsburg, Germany or streaming on personal VR headsets to serve the theatre on demand. As intendant and VR enthusiast André Bückler explains, this works with the classical audience because the usability is so easy (Mustroph, 2020). Five ballet and plays have already been produced and are available on the Website of Staatstheater Augsburg ([staatstheater-augsburg.de/vr\\_theater\\_at\\_home](http://staatstheater-augsburg.de/vr_theater_at_home)). The VR theatre will stay online beyond COVID-19 lockdown times, focussing on people unable to physically visit a theatre.

**Contact:**

[www.staatstheater-augsburg.de](http://www.staatstheater-augsburg.de)



John Legend performing in WaveXR Image Credit: WaveXR

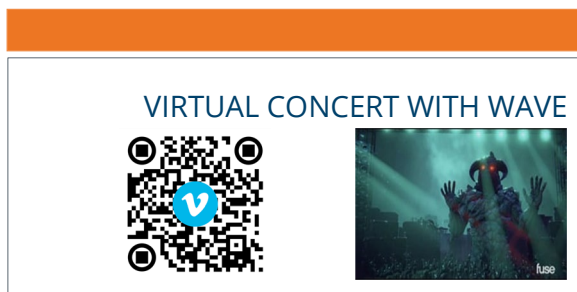
A new era of digital entertainment was fast-tracked with the pandemic with companies (**WaveXR**, **MelodyVR** or **NoysVR**) offering virtual music experiences. The next generation concerts do not only empower artists but creates a more inclusive community that go beyond physical, social, or cultural boundaries. Being immersive, interactive, and highly entertaining, these platforms provide an opportunity for artists who are not dependent on live concerts and shows but

transfer their performances into virtual venues streaming live via Social Media Platforms (YouTube, Twitch, TikTok or Facebook), other digital streaming, and gaming channels or on Steam and Oculus. The events provide new monetarisation possibilities for product placements, brand sponsorships or online purchases. Connections between fans and their idols is being reimagined with new digital and hybrid events e.g., from Miro Shot at the Centre for contemporary Art in Amsterdam or streamed AR concerts on the social media platform TikTok by R&B artist The Weeknd generating 2 million views and \$350,000 for an equal justice initiative.

John Legend, Alison Wonderland, Lindsey Sterling or REZZ? Platforms like the Los Angeles-based start-up **Wave XR** define the future of virtual entertainment that enable the audience to be part of the music experience. Despite having forecasted a bright future for Wave XR, it shut down its Steam and Oculus Store beginning of 2021 due to slow VR adaption.

**Contact:**

wavexr.com





## Immersive Cultural Venues



Image Credit: Chateaux de Versailles

The constraint in physical visitability urges cultural venues to find a new place in society, online and offline. Museums found an alternative way to make their art exhibitions accessible for visitors and art lovers. In a series of virtual guided tours, and activities (home art and sketching classes) the exhibition and related content is now available to a wider audience. With the aid of online platforms and immersive technology, museums stay connected through the transformative power of art.

The responsibility of museums and cultural venues to facilitate meaningful narratives between collections and viewers mainly through physical exhibitions on-site need to be redefined. How can bridges be built between audience and artist without the need for physical presence? Will it replace on-site experiences? What are the expectations of online visitors for art exhibitions and the display of art? Common approaches so far include 360 videos and walk-throughs with some interaction.

The Castle of Versailles has partnered up with Google Arts & Culture since 2009 to create a virtual reality tour, VersaillesVR: The Palace is yours, which lets visitors explore the extraordinary architecture and interior design of the palace with Oculus Rift or HTC Vive. As a free app download from Steam, the user can immerse into the luxury experience from wherever they are. The app provides audio and overlay content of over 150 art works with explanations from the museum's scientific team as well as exclusive content from antiquities, furniture, and paintings closer than it would normally be allowed in the real exhibition. Using photogrammetry, the space can be experienced just as in real life providing a lot of detail of the world-famous décor and objects. The aim of the palace management is to share as much free content and knowledge with visitors as possible—life and digital to encourage new visitors to come to the location by using different media tools, such as StreetView, 3D videos or VR ([chateauversailles.fr](http://chateauversailles.fr), 2019).

## Immersive Art and Museum Exhibitions



Virtual Art Gallery Image Credit: [sabil-illustrations.com/](http://sabil-illustrations.com/) Artsteps

Many of the (earlier) examples within VR represent a reconstruction of museums' real environment or an enrichment of these. Others have been recreated through 360 recordings and computer-generated software. Virtual gallery platforms such as **ArtSteps** ([www.artsteps.com](http://www.artsteps.com)) enable private artists, universities, or gallery curators to create a personalised 3D virtual experience for desktop, mobile devices, and head mounted displays (HMD). The spatial experience provides possibilities for marketing campaigns, education, or immersive art events to reach a wider audience of art visitors and purchasers to browse through hundreds of art pieces without the necessity to visit a gallery, auction, or art fair. 'Artsteps makes art not only more accessible by bringing the gallery to people's homes but is a gate to reach younger audiences.' reports freelance artist and illustrator El Mehdi Sabil.

Some VR spaces even create museums that do not exist. An example of a non-existing museum aimed at VR art is the **Museum of Other Realities** ([www.museumor.com](http://www.museumor.com)).



Examples created within BUAs are the **Van Gogh museums** designed using Samsung mobile VR. Based on Japanese Art and Van Gogh paintings, to research examines VR experiences of users such as walking patterns and viewing behaviour to identify the intention to visit the museum. On the other hand, the purpose of the project was to measure enriched experiences such as spatial sounds and music reflecting music composer feelings of the paintings that interact between painting and visitor. More information can be obtained through the research papers connected with these VR productions.

A virtual experience provided with **ArtSteps** or on other VR platforms may not replace the real-life interaction with the paintings but may provide the means for a remote-living or less privileged audience to access art and culture.

**Being There** is the first VR museum about migrants and refugees that was created based on real immigration and refugee centres in Mexico. A destination that normally is avoided by the society gets a place in VR with authentic stories about the migrant journey.



## Immersive Outdoor Experiences



[store.steampowered.com/app/407710/The\\_Grand\\_Canyon\\_VR\\_Experience](https://store.steampowered.com/app/407710/The_Grand_Canyon_VR_Experience)

When it comes to exploring a place, it is all about the sense of being there. Feeling present in the place and time, we visit. Some marketing strategists have picked up that idea and created experiences in which people can travel to any place in the world at any given time through the perspective of a local. Where some 360 imagery are rather limited in interaction to look around the immediate scenery (earth.google.com or i.e., www.360virtualtour.co) or use aerial drone photography, other virtual walks allow for extended forms of interaction. The Grand Canyon (USA) were among the first destinations to use VR devices for taking users on virtual walks. The Grand Canyon VR experience inspires thousands of undecided visitors to explore the National Park online first. The whole virtual environment is computer-generated with the support of procedural AI. Digital visitors manoeuvre a stand-up paddling (Sup) board or a kayak with the HTC Vive or Oculus Rift via controllers over the virtual Little Colorado river (The National, 2019).

The (re)construction of virtual worlds is particularly interesting for remote, or protected environments which become virtually accessible with photogrammetry-based content such as the one produced by Unreal of **Rural Australia** that authentically captures real locations and invites travelling to the reconstructed and remote outback.

Historical experiences such as **The French Conquest of Maastricht** invite to a virtual stroll through the medieval city. A virtual 3D model of the city of Maastricht forms the basis for a museum exhibition. Volumetric video adds the personal experience to the maquette through games and stories ([smartvenue.nl/en/chronosphere](http://smartvenue.nl/en/chronosphere))

Another example is **uncharted caves of Kyrgyzstan**. An interactive 3D experience for VR that helps tell the story of a remote region of Kyrgyzstan that needs to be protected. The whole area is scanned and will be enriched with interactive VolCap humans.

BUs among others created the virtual reality-based diving experience **Green Bubble** that stimulates sustainable diving in open protected diving areas ([www.breenbubbles.eu](http://www.breenbubbles.eu)).



## Challenges & Possibilities of XR

XR technologies create a valuable virtual alternative in situations with limited accessibility, and offer an opportunity to redesign content from history, performance to visual arts to appeal to a wide audience. It has the potential to tear down barriers of social norms and conventions, time or location and allows for more access across cultures and generations. However, there are also some challenges and opportunities to take into consideration as we advance this technology in the industry.

### Accessibility and Adoption

To step into a seamless virtual environment as described in some of the use cases requires overcoming some key challenges which vary across countries, sectors, organisations, and places within the European and global tourism industry. There may be difficulties in implementing digital technologies such as access to training services, insufficient knowledge of the technologies and their possibilities and uncertainties in funding allowances while having a lack of affordable 'off-the-shelf' solutions (Dredge et al., 2018).

Equally from the customer perspective, a central obstacle is the limited accessibility to those who have the means, technical understanding, and facilities to do so. Offering immersive tourist experience only to those who have the means might create more discrepancy in foster inequality. It is important to democratise access and reduce high entrance barriers such as costs, limited skill level, or usability difficulties that immersive worlds do not remain exclusive places for an elite minority.



XR applications need to be trustworthy. To avoid a similar discussion as we have recently increasingly seen with Social Media giants, virtual platform services need to inform about the type of data that will be collected and stored. Customers are increasingly concerned with what happens to their data and who has access to it. Additionally, when content is uploaded to an openly shared platform, the question of ownership of digital artifacts remains to be answered. In the quest of creating competing virtual worlds, this might also be a filling time to talk about ethical and legal considerations.

### XR Hardware Sales

Expectations predict a net positive for XR adoption, as families and friends as well as businesses and customers find new ways of socialising, remote travel and collaboration which is expected to translate into an increase of hardware sales. However, the current sometimes premature state of XR technology needs to be recognized and sales numbers might only gradually increase, as mass consumer adoption will depend on consumer trust in the technology, also because XR headsets differ in price and quality. While short-term there was a high demand of XR hardware in 2020, it is important to monitor further demand as projections might be prudent due to the uncertain outcome of the crisis (Merel, 2020). Companies growing from the hype in 2020, have rapidly adapted their business model or shut down, such as Wave XR, as live stream platforms and established games turned out to be an easier and cheaper version for end-users (Carlton, 2021).

### Content Creation

Mass adoption of XR applications require the understanding of how to create attractive and engaging content that speaks

to the wider audience and provides value for tourists. There is no added value for the tourist in offering virtual walking tours when the audience gets no explanations about the touristic sites which are passed on the way. Storytelling is an integral part in onboarding the tourist to the customer journey and in communicating a consistent story through multiple channels. Key questions remain of who will build, govern, and control these omnichannel structures in which billions of users connect, create and exchange content. Independent content creators, agencies, and artificial intelligence solutions offer different ways of content development or curation but need more clarity on how the interaction will be regulated.

### Viable Business Models

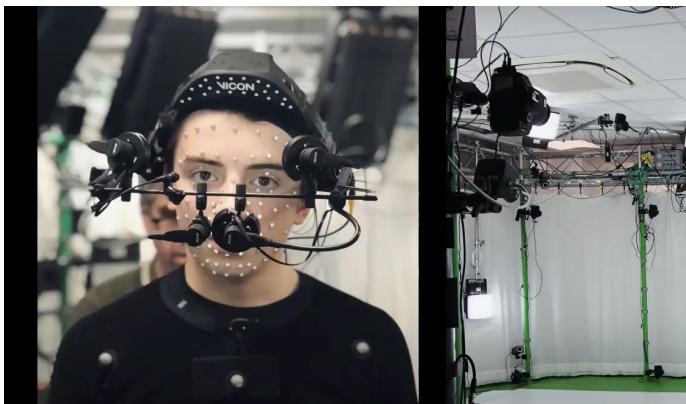
Current business models in tourism are largely based on receiving visitors in a contextual location, which is arguably not possible to completely transfer and offer in the virtual environment. Thus, asking visitors to pay the full ticket price or entry fee might not always be appropriate. However, immersive experience developments often involved monetary and administrative expenses, which cannot be compensated by *free to pay* (F2P), *pay as you like* or other voluntary *donations* as a sustainable business model. Although in some cases free content is necessary to ensure cultural offers are available as a human need (Verberk, 2020). To attract new audiences, many users already have access to free online content through various means. A change of mindset and approach is needed to identify alternative ways of capitalisation possibilities.

Closures and the absence of travel have been proven how quickly the tourism industry transfers to digital content. Challenges ahead are to make this digital content part of a viable income. COVID-19 pandemic turned out to be a digital

technology accelerator to bridge the gap between online and offline travel if we use this time to investigate new formats, experiment small scale and evaluate what is sustainable for the future (Verberk, 2020). What we certainly know is that the longer hotels and destinations remain closed, the more difficult it will be for business operators to turn a profit. In this situation, who will be able and willing to invest big sums into exploring technological solutions while struggling to cover existing costs? Most tourism companies are expected to be impacted by the crisis in the coming years, which creates a risk of stagnated innovation in the industry.

### Technological Advancements

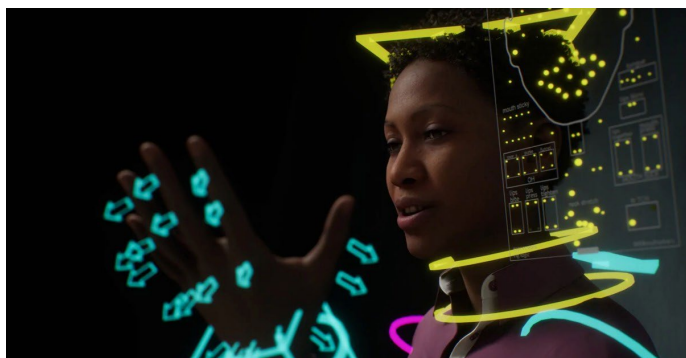
Online and virtual might be the only viable avenue to build resilient future-proof business models. XR offers numerous opportunities to re-create our world. This is the time when XR needs to define itself, allowing users to feel, touch and interact with the world and others.



Motion capture tracking technology Image Credit: ARVRGS Keynote – Performative R A New Techniques of Storytelling

Hand tracking for AR/VR experiences will offer a huge leap in this development. Initial algorithms were developed tracking high-fidelity hand deformations through self-contacting and self-occluding hand gestures. Users will be able to interact in VR by shaking hands or grabbing virtual objects. In combination with real-time face tracking and motion capture, even more realistic, human-like characters can be created.

**Virtual Humans**, the next generation of meta humans® from Ubisoft, already changes the world of games and entertainment. These virtual, non-real individual photorealistic humans can be used in conjunction with modern motion capture and animation techniques for creating lifelike movements and human interactions scenes with famous artists or indigenous communities enabling interactions and conversations. The Meta Human Creator crafts highly realistic human faces and enables more realistic body movements and facial animations in combination with AI it is possible to generate startlingly realistic fake faces (WhichFacelsReal.com).



Metahuman Image Credit: Unreal Engine

Another recent technology, volumetric video capturing adds realistic-looking virtual 3D humans and objects and movements into the real world. Within a **Volumetric Capturing** (VolCap) studio, dozens of cameras capture the movements of a human simultaneously and translate them into a digital twin. These Volumetric Captured humans can then be integrated in any digital world (such as 2D, AR, VR), with the advantage that they are able to walk and look around. By implementing a digital twin of a real person into VR, the application becomes more believable and human-like.



Chronosphere (Eindhoven) Virtual Production Studio Credit: smartvenue.nl

For tourism, this brings substantial opportunities, letting the audience time travel into the medieval ages or remote tourism destinations. BUAs started to participate in Chronosphere, that allows creators and scientists to experiment with VolCap, using a unique studio in Eindhoven, NL a unique opportunity within the Benelux. Many of the projects are aimed at tourism application cases.

Another prospect is **Virtual Production** for virtual and real video productions enabling to use the multi-functional collaborative platform to record 360 virtual theatre, dance, or interactive performances visualising virtual and extended reality locations. The presentation or performance takes place in front of an LED wall on which the virtual content is projected. The technology is based on the Unreal game platform which allows for a seamless and real-time interaction of virtual and real characters.



Virtual Production Image Credit: ksusentinel.com

## The Future of XR in Tourism

The paper presented a range of XR application cases for travel, tourism, and beyond. Virtual and digital technologies already have and will continue to have an enormous impact on tourism developments, which requires us to think about the efficacy and effects immersive technologies on the industry. Immersive technologies are widely used as part of the value proposition for companies to enhance the customer journey online, remote, or on-site. What is more is, that we count on XR applications for training simulations, simultaneous communication, and virtual social interactions. With the latest hardware developments such as haptic gloves, smart sensors, tailor-made VR body suits, or virtual productions, experiences become close to reality focusing not only on visual senses but a full-body sensation incorporating augmented smell, audio surround sound systems, and body interactions. These technological developments will change people's individual experiences by personalising the use of immersive technologies with for instance avatar and environment configurations.

More important than technical aspects are the why we design experiences and stories with immersive technologies. How do we transform content that the user find herself immersed into the story as a protagonist as opposed to a viewer? Will we in the future travel in form of a digital avatar in a shared virtual space, the metaverse, with digital humans as our travel guides? A space in which we all can travel freely, sustainably and without boundaries.

Immersive technologies will have a major effect on society and how we live, interact with each other and travel. Therefore, societal questions are a major responsibility along with technological advancements of social scientists, policy makers and developers.

Societal repercussions of these technologies are very important to investigate at an individual, organisational and cultural level. This might encompass topics such as:

- < Raising questions about ethics, ownership, data privacy, and safety issues
- < Ensuring equality, diversity, accessibility, and inclusion among minorities and lower-income users
- < Identifying societal changes in behaviour, social paradoxes, and cultural shifts
- < Raising awareness of the existence, impact, and limitations of immersive technologies among the public.

Such as digital platforms (e.g., Booking, Uber, Google) disrupted the tourism industry some twenty years ago, immersive technologies will transform organisations, business models and job profiles. For this, researchers and industry professionals need to cater for.



## Conclusion: The Future is Hybrid

As the presented use cases show, travel might not become redundant or entirely virtual even though it might be practically possible. Tourism sites become more accessible in the Immersive Tourism Reality Continuum, solving issues of being out of reach, temporary closed or not accessible any longer. With destinations moving into virtual, DMOs not only compete on the world stage with each other as they have always done, but additionally enter into a competition with alternative leisure activities such as games, events, movies, and concerts. We enter into a rivalry of people's time and attention.

Foremost tourism destinations that are suffering under tourism pressure, investing in digital technology provides a chance to manage tourism capacities. Similarly, an increasing number of tourist sites are required to be preserved due to excessive tourist numbers accounting for harms at the Great Barrier Reef or the Mount Everest. With VR, these sites become accessible even for the less experienced hikers engaging into an immersive VR experience which can be reconstructed to an impressive detail. This also prevents users from putting themselves or others at risk, while experiencing the extraordinary trip from the comfort of their own home. Such developments can further contribute to the protection of our environment, as the devastating amount of environmental pollution and littering left at tourism and nature sites will decrease. However, based on our inherent human need for connection, we do not expect to fully replace live events, travels, and museum visits. There might be an opportunity to replace physical business meetings or conferences, but a more likely scenario will be the formation

of hybrid versions that offer a digital overlay or hybrid approaches to reach a wider target audience.

Where early VR experiences were perceived impersonal and isolating (e.g., VR roller-coaster rides at amusement parks), simulated worlds become enriched with virtual humans, which increases the sense of social presence and immersion in the virtual world. XR technology is being continuously improved, increasing opportunities for remote travel. With technology advancements in XR we can deliver more real and new experiences, supported by automation, language processing, AI, and cinematic and volumetric VR. Seamlessly engaging multiple senses in virtual worlds will come close what we only know from science fiction movies such as the Matrix or Avatar.

In the end however, it is not about the technology itself, but the added value created for and with tourists. How the technology integrated to create value and build digital connections, particularly in times of temporary imperative social distance measures is vital. From what we have experienced under COVID-19 regulations in the past year, we are still in need of real human connections based on facial expressions, gestures, scent, and banter. How can we fight loneliness through virtual worlds and have a dialogue without building relationships? Simulating a conversation with a chatbot or virtual avatar as presented with FB Horizon or Virbela still feels unnatural and challenging. We need relational context, visual cues, facial expressions, tone of voice, and body language to interpret meaning and understand each other. Without personal connections and relationships, there exists a sense of distance to others sometimes allowing for toxic environments to be formed on platforms with high social traffic. Ignoring such implications

while developing XR solutions can have a huge impact on the future of society as we might create more problems being together online than being separated offline. Therefore, it is not only valuable but highly necessary to bring together multiple disciplines and perspectives in the development process to discuss and respect various conditions and effects that XR will have on a multi-faceted industry such as tourism.

# Breda University of Applied Sciences

## Profile

Breda University of Applied Sciences (BUas, Breda, the Netherlands, est. 1966, 7,000 students, prev. NHTV) is a medium-sized, specialized University of Applied Sciences with education and research in eight domains: tourism, hotel and facility, leisure, logistics, built environment, games (entertainment, serious) and media (virtual reality).

BUas provides BSc. education, professional Master education in these domains, and MSc. (in Leisure studies with Tilburg University, Imagineering). These educational programs are clustered into five BUas academies: Games & Media, Hotel & Facility, Tourism, Leisure & Event Management, Built Environment & Logistics.

As a specialized institution in higher education, BUas attaches great importance to continuous knowledge development and innovation, in collaboration with science, business, government, and societal organizations.

## Research Facilities

### R&D Lab 'Cradle'

CRADLE is the Research & Development lab of the Academy for Games & Media at Breda University of Applied Sciences. At this lab cutting-edge, innovative games & media applications are designed and developed through projects conducted on behalf of three professorships:

- < [Dr Marnix van Gisbergen](#) (Digital Media Concepts)
- < [Dr Mata Haggis-Burridge](#) (Creative & Entertainment Games)
- < [Dr Igor Mayer](#) (Applied Games, Innovation & Society)

The Academy of Games and Media's R&D department has extensive experience in applying video game technologies to diverse fields, from artistic pieces to organisational simulations. These projects include applications that have used motion-capture, AR/VR, serious and simulations as well as entertainment games. Funding for projects comes from national and international grants (Horizon 2020), private businesses, or internal investment from BUAs itself. This has resulted in a highly diverse portfolio of previous work.

### Experience Research and Design

Experience Research and Design integrates two research labs: the experience measurement lab and the storytelling lab. It is a multi-disciplinary facility in which partners can measure, experiment with, and evaluate customer experiences. The lab is a cornerstone of BUAs' Designing, Measuring, and Managing experiences research theme, which offers a one-stop shop for all customer experience needs. These components include measuring:

- Mobile experience measurement in the field through complementing research methodologies
- Measuring brain activity with EEG in a lab environment
- The lab is equipped with a wide range of VR headsets, controllers, and sensors to measure behaviour and movement.

Experience Research and Design provide services from testing and evaluation equipment for minimal viable versions of a prototype or concept to be tested with an audience, to testing fully fledged immersive applications for adaptation, usability, and user experience. The professorships linked to the Experience R&D lab are:

- < [Dr Marcel Bastiaansen](#) (Leisure and Tourism Studies)
- < [Dr Moniek Hover](#) (Storytelling)

### **Motion and Body Capture**

Motion capture is a technology wherein the physical movements of a person, their face or any object are recorded. The recording can then be transferred onto digital assets, like a virtual reality or video game character, resulting in the asset moving in the same way that the original performance moved.

The research team has already built a full face-scanning studio and begun work on an automated pipeline for scanning, rigging, and animating faces using the Facial Action Coding system and realistically rendering it in Unreal Engine.

### **Virtual Collaborative Stage**

For 2021, BUas partnered up with ROE Visual to create a virtual collaborative space with 3 LED walls and space studio. Researchers, virtual production students and game designers are working together on virtual video productions.

## Research Projects

### DigiTourism

Many business intelligence reports demonstrate that Digital Realities (e.g., virtual reality and augmented reality) are becoming a huge market development in many sectors. The tourism industry is no exception, and the sector needs to innovate to get ahead of the curve of this technological revolution. Europe must innovate to get ahead of the curve of this technological revolution, but this innovation needs public support. The DigiTourism project intends to improve policies of the 8 involved partner regions, to foster tourist channelled digital innovations.

WHEN	2018-2022
FUNDING	INTERREG EUROPE
CONTACT	JESSIKA WEBER SABIL WEBER.J@BUAS.NL
LINK	INTERREGEUROPE.EU/ DIGITOURISM/

### Immersive Sustainable Food Experience Design

We live in a society that is increasingly dominated by technology-mediated interactions and consumption of experiences. It has opened pathways to innovative immersive technology concepts in the food and dining context, contributing to the development of a consumption-oriented society. This project addresses the challenge of how to stimulate consumers through immersive technology designs to make conscious choices leading to more sustainable behaviours in the food and dining context.

WHEN	2020-2022
FUNDING	RAAK-SIA
CONTACT	DANNY DAI-IN HAN HAN.D@BUAS.NL



## Chronosphere

The project provides a unique testing ground where the creative sector and education work together to better understand the possibilities around volumetric video capturing. Within a volumetric studio, dozens of cameras capture all the movements of a living subject simultaneously. These recordings are converted into a fully moving and digital image, which results in an image that is barely distinguishable from reality. Chronosphere gives content creators and scientists the unique opportunity to experiment with volumetric capturing, using the newest volumetric studio within De Effenaar.

WHEN	2019-2021
FUNDING	CLICKNL, Metropool Regio Eindhoven (MRE), Rijksdienst voor Ondernemend Nederland (RVO)
CONTACT	MARNIX VAN GISBERGEN GISBERGEN.M@BUAS.NL
LINK	SMARTVENUE.NL/ CHRONOSPHERE

## VIBE

Can computers talk like humans? Look like humans? Behave like humans? Project Virtual Humans in the Brabant Economy (VIBE) focuses on developing and testing virtual humans to make this happen. The virtual humans developed by VIBE will be able to communicate with normal people in a natural way, both verbal and non-verbal, and deliver a valuable contribution to the training of healthcare professionals. The agents developed by VIBE can be used in any training simulation in various instances, including virtual, mixed, and augmented reality. VIBE agents are designed to also customize for other domains such as tourism and leisure to enhance training, education programs or leisure experiences.

WHEN	2018-2022
FUNDING	EU EFRO, Province of Noord Brabant, municipalities.
CONTACT	IGOR MAYER MAYER.I@BUAS.NL
LINK	<a href="https://youtu.be/ZXVOXHRKIL8">YOUTU.BE/ZXVOXHRKIL8</a>

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Built Environment



Facility



Games



Hotel



Leisure & Events



Logistics



Media



Tourism

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