



VIRJOX

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Chelsea Kelling, Tuuli Keskinen, Alisa Burova, Ville Mäkelä & Jussi Karhu (eds.)

VIRJOX
Engaging Services in Virtual Reality



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– Engaging Services in Virtual Reality

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Engaging Services in Virtual Reality

Tampere University of Technology. Laboratory of Pervasive Computing
Tampere 2018

Foreword

This booklet showcases findings from a research project called *VIRJOX – Engaging services in virtual reality*¹ carried out in Finland between the end of 2016 and summer 2018. VIRJOX focused on the design, implementation, and evaluation of immersive experiences for digital services, primarily based on virtual reality (VR). The two application areas were journalism and airport context.

The VIRJOX project was carried out as a collaboration between the following three universities and their departments and research entities:

- § Tampere University of Technology (TUT): Department of Pervasive Computing, Research Group of Human-Centered Technology (IHTE), and Department of Industrial and Information Management, Knowledge and Learning Research Center
- § University of Tampere (UTA): Faculty of Communication Sciences, Tampere Unit for Computer-Human Interaction (TAUCHI) and Tampere Research Centre for Journalism, Media and Communication (COMET)
- § University of Jyväskylä (JYU): Department of Language and Communication Studies, Journalism program

Project contributors within the universities were:

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Esa Sirkkunen (COMET), Markku Turunen, Ville Mäkelä, Jussi Karhu, Alisa Burova, Jaakko Hakulinen, Tuuli Keskinen, Pekka Kallioniemi, Sunita Dash (TAUCHI), University of Tampere

Turo Uskali, Pasi Ikonen, Helena Hirvinen, University of Jyväskylä

The university research groups worked closely together within the project and in the cases. The main responsibility for design and user experience (UX) evaluation was at IHTE (TUT). The implementation was carried out in TAUCHI research center (UTA), where also the storytelling application for airports was taken from the initial idea to prototype design and implementation, and the application was evaluated. COMET (UTA) was responsible for studying the journalism viewpoint jointly with the University of Jyväskylä. Value creation was studied by the Knowledge and learning center at TUT.

The participating companies were Sanoma Media Finland Oy, Finavia Oyj, and Futurice Oy. The project was funded by Business Finland (formerly Tekes – the Finnish Funding Agency for Innovation), the universities, and the participating companies. We want to thank all stakeholders for their collaboration and making this groundbreaking project possible.

The goal of this booklet is to share key learnings and insights with companies and practitioners, but also with the wider public interested in the studied topics. For researchers, the booklet presents our research topics with short introductions and references to our publications.

¹ VIRJOX website: <http://virjox.hti-tampere.fi/>

Our work continues both with journalism and in a number of other application areas. We will be publishing an international book with other researchers on immersive journalism via Routledge in autumn 2019. We have also received funding from Helsingin Sanomat Foundation to continue our work – focusing on *Emotions and Responsibility in Immersive Journalism – EMORES*².

You are welcome to contact us for more information!

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² EMORES website: <https://research.uta.fi/comet-en/emores/>

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1. Developing immersive storytelling applications efficiently: three case studies

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Otto Kauhanen, Chelsea Kelling, Heli Väättäjä (IHTE, TUT)

In order to study how immersive storytelling applications could be produced, we conducted three case studies, each containing the design, development and evaluation of an immersive application. In this chapter, we give an overview of the designed stories, their implementations, and the evaluations.

The design and user experience evaluation of the journalistic prototypes *Hugo Simberg VR* and *Eternal Youth* utilizing 360° photos or 360° video footage – also known as omnidirectional video – was headed by IHTE in the Tampere University of Technology. TAUCHI in the University of Tampere implemented all three prototypes. Also, TAUCHI designed and evaluated the storytelling based shopping experience application, *the Finnish You*, in collaboration with other research groups.

Case *Hugo Simberg VR*³

We started this case with a rough idea of telling the story of late Finnish artist Hugo Simberg using immersive technologies. In the beginning of the project we had workshops with different stakeholders, where we brainstormed for ideas. One goal was to develop an application that could be used as widely as possible. We wanted people to be able to experience immersive storytelling without high-end devices and expensive head-mounted displays (HMDs) so we ended up designing an application that could be viewed with cheap HMDs like Google Cardboard using their own smartphones. From VR development perspective, we studied how immersive content could be produced in cost-efficient means.

During the iterative development process we built prototypes and ran quick user tests to get feedback as early as possible. The development was assisted by user experience design methods. Based on the workshops, brainstorming sessions, feedback from the users, and background research on the subject, we created a biography of Hugo Simberg as a VR experience. (More information on the design process can be found in chapter 2 *Lean UX design approach applied to immersive journalism*.)

The story of Simberg is told through his art (see Figure 1 and Figure 2). In the experience, the user can explore two locations, the main hall of Ateneum art museum in Helsinki and Tampere Cathedral. Both locations include paintings and frescoes by Hugo Simberg.

During this case, our guiding questions for the iterative development were, e.g.:

- § How should the story be presented?
- § What is a reasonable amount of content in this kind of an application?
- § How to create an immersive VR application that could be used even with low end mobile devices?
- § How to create immersive VR content efficiently and in cost-efficient means?

³ Hugo Simberg VR can be found with its name on Google Play Store or downloaded through <https://play.google.com/store/apps/details?id=fi.uta.coms.tauchi.hugosimbergvr>.



Figure 1: Free exploration using hotspots. In the VR experience the user can move around freely using interactive hotspots. The hotspots are activated using dwell-time with head rotation. Background music is used to distinguish different environments from each other.

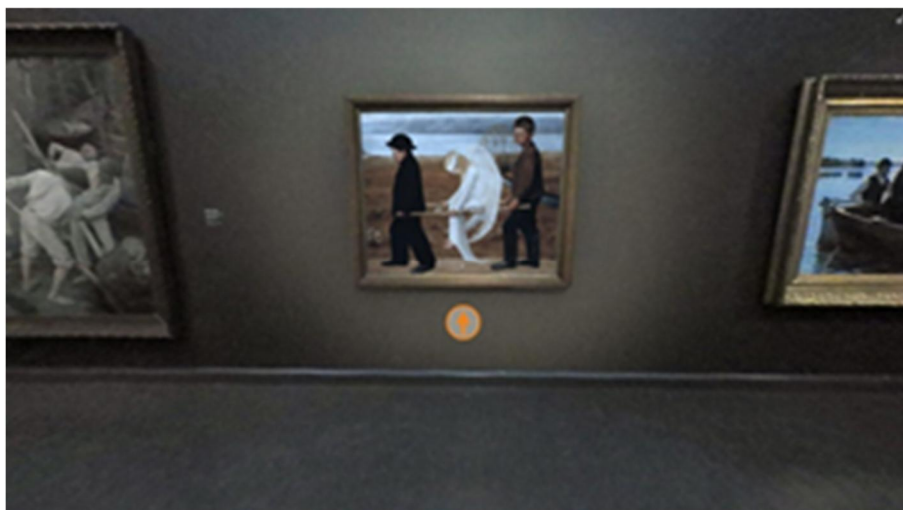


Figure 2: Storytelling through art. When the user comes next to a painting by Simberg in the experience, they get to hear a short story about the painting and about the author's life at the time of creating that piece of art. This painting, Wounded Angel, is located in the Ateneum art museum, and it acts as a link between the two virtual locations, because a version of it can be found also as a fresco in the Tampere Cathedral.

Evaluation

Because our Hugo Simberg VR prototype was created through an iterative development process, user testing was also done in this manner. Naturally the prototype was tested by colleagues and project partners also, but here, we will discuss the three main cycles of testing in which data was collected from real users and analyzed: The first conducted in universities' hallways, the second conducted in the Helsinki railway station and Ateneum art museum in Helsinki, and the third, and most extensive, testing conducted

in a laboratory setting. As explained below in chapter 2, after each round of testing, the prototype was improved based on the feedback from the evaluations and user feedback.

In the first user study, we aimed to collect general feedback about the application and understand how the users experienced the application. Consisting of 13 participants, the study was conducted in the hallways of the Tampere University of Technology and the University of Tampere. The participants were recruited on the spot; as students walked by, we asked if they would like to try out the VR application. Participants first filled in a background questionnaire on demographic information as well as previous VR usage. Then, they were told how to use the VR device (Samsung Gear VR headset and LG G3 mobile phone), and the VR experience was started. Once finished, the participants were interviewed with questions related to the general experience, and finally, they filled in a short questionnaire, which pertained to the experiential components of virtual reality (see Kauhanen et al., 2017, for details).

To analyze the qualitative results, the interview data were transcribed, broken down into individual comments, further coded according to their valence (positive, negative, or neutral), and finally sorted into broader themes or categories. In total, seven main themes in relation to user experience emerged: Immersion, Presence, Disorientation, Sense of Control, Pleasantness, Exploration, and Simulator Sickness. The participants reported the application to be pleasant and fun, and the majority said that they would like to use it again. The main issues reported dealt mainly with users' inability to navigate the virtual space due to ambiguous icons and lack of understanding of the spatial layout. Additionally, many participants complained about the visual quality of the images and that the outside environment was too noisy to be fully immersed in the experience.

Based on these findings, small improvements to the prototype were made, such as improving the image quality and re-designing the icons to better represent viewpoints and provide clearer navigation (Kelling et al., 2018). Additionally, we wanted to apply stronger elements of storytelling to increase immersion and experience engagement. To achieve this, we added two new elements in the form of audio: ambient music and narration. The content of the narration concentrated on the life and artwork of Hugo Simberg. As the user moves from viewpoint to viewpoint, they are introduced to the artist and begin to learn more about the story behind him and his paintings. In addition to the narration, soft ambient music could be heard in the background, drawing the user further into the virtual environment in a subtle yet realistic way. To evaluate the prototype, a quick testing session was conducted in both the Helsinki railway station and the Ateneum art museum. Also here, the participants were recruited randomly as they walked past. Because of the busy nature of the testing locations, data was gathered with a questionnaire only. The questionnaire was built off of previous research in the field as well as the user experience dimensions identified in the first study.

In total, 32 individuals participated in the second evaluation. The testing procedure followed the same structure of the first study, excluding the interview portion. Overall, participants enjoyed using the application, and the questionnaire results imply that the audio additions were well received. The participants reported that the application was easy to use, the experience was memorable, and that they would recommend the experience to friends or family. However, there were still issues pertaining to navigation and image quality. Again, small changes related to these issues were made, and a third testing was conducted.

Because the second testing only included quantitative data from the questionnaires, the analysis of the data was limited in the sense that although positive and negative aspects were identified, it was impossible to understand the reasoning behind that data. To mitigate this, a final, more in-depth testing was conducted in a controlled laboratory setting (Kelling et al., 2019). This study included both questionnaire *and* interview data, and consisted of responses from 21 participants. The questionnaire covered different aspects of the experience, including emotional reactions, sense of immersion and presence, and aspects of the virtual environment itself. Figure 3 details the questions used and the percentage of participants' responses. Finally, the interview data was transcribed and coded in the same manner as in the first user study. Chapter 3 *UX Dimensions in Immersive Storytelling* describes these results in detail.

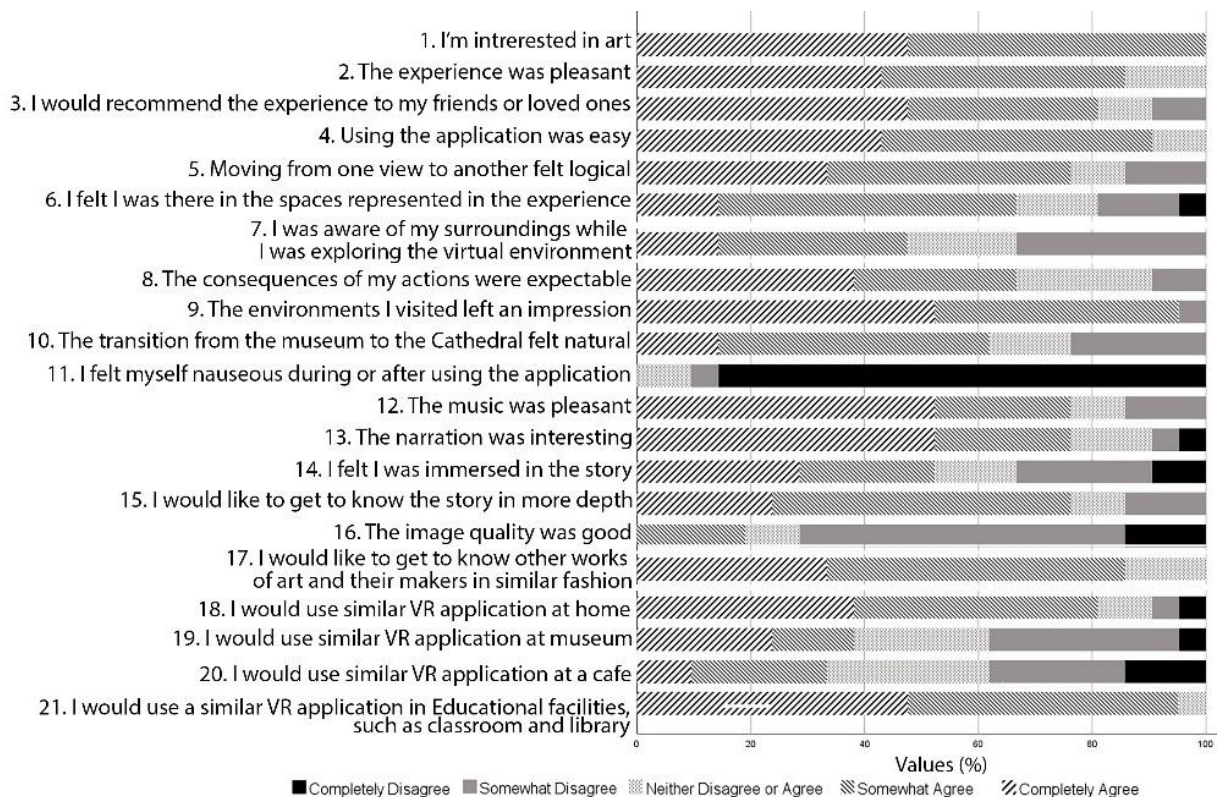


Figure 3: Questionnaire items and results from the third evaluation of the Hugo Simberg VR.

To summarize, the Hugo Simberg VR and its evaluations demonstrate that it is possible to create efficiently immersive interactive VR content with 360° photos with auditory narration using storytelling. The result could be utilized even with low-end devices, allowing mass distributions.

Technical aspects and availability

Hugo Simberg VR application is publicly available and can be downloaded from Google Play Store⁴. The application can be run with most Android-based smartphones equipped with a gyroscope, and the content

⁴ Hugo Simberg VR can be found with its name on Google Play Store or downloaded through <https://play.google.com/store/apps/details?id=fi.uta.coms.tauchi.hugosimbergvr>.

can be viewed using any Google Cardboard compatible VR headsets. Hugo Simberg VR is built on Unity game engine using Google VR SDK. The interactive elements in the application were added and defined using a 360° editor for interactive omnidirectional content made by TAUCHI.

The 360° editor (see Figure 4) is a cloud-based application which turns 360° videos and images into interactive scenes. Interactivity can be created with hotspots, which can be 2D icons or 3D objects and include transitions to other scenes and text, images and audio. The exported end results can be viewed, and interacted with, on desktop and tablets, with HMDs, and in CAVEs.



Figure 4: The 360° editor and its different features.

Read more & references

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Case *Eternal Youth*

The goal of the Eternal Youth case was to investigate the experiential factors of immersive journalism – how journalistic articles could be transformed into immersive virtual experiences, and how such experiences fare compared to more traditional means of news consumption. From a technological perspective, we wanted to study how high-quality VR content could be produced in cost efficient means by combining both natural and computer-generated immersive audio-visual material.

This case was driven by the following research questions:

- § Where does VR fit in the world of journalism?
 - How can VR be best utilized in giving consumers the best news experience?
- § How do news/information experiences differ across different forms of media?
 - What type/combination of medias provides the best experience?
- § How immersive VR experiences could be produced efficiently by combining natural and computer-generated audio-visual content?

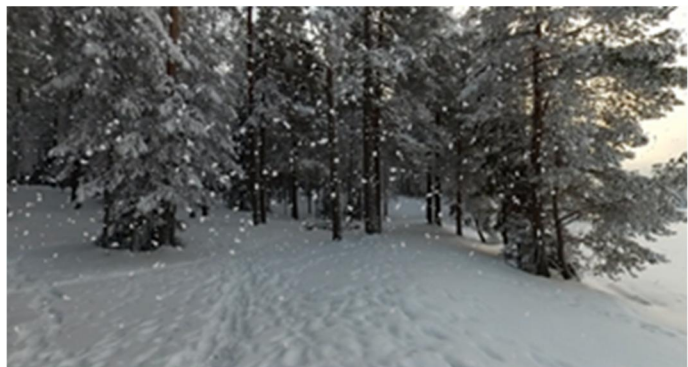
We took an article from Helsingin Sanomat, detailing the work of Nobel-prize winner Elizabeth Blackburn, and created a 360° VR experience summarizing the article information. The article was about Blackburn's research on telomeres – compound structures at the end of a chromosome. Telomeres play a significant role in aging, as telomeres shorten over time. Blackburn discussed that telomeres can be affected positively by, for instance, eating healthy, exercising, and meditating.

Based on this, we created the Eternal Youth VR application, which consists of two phases, demonstrated in Figure 5 and Figure 6 below.



Figure 5: A short informative description of the topic. The article content is narrated to the user by a voice actor. The narrative is supplemented with animations and ambient background music.

Figure 6: A meditation exercise. The user is transported into a 360° environment, a winter forest near a frozen lake. The narrator guides the user through a short, relaxing meditation / breathing exercise. The virtual environment is complemented with particle effects (snow, fog, clouds), and 3D audio effects (wind, ambience).



Eternal Youth is built on the Unity and Steam VR platforms, which can be run on most commercial, cutting-edge VR headsets. In addition to the VR version, a mobile version was also developed, wherein users can rotate the mobile device to look around the scene.

Evaluation

Considering the Eternal Youth prototype's evaluation, we aimed to investigate not only the experiential factors of an immersive journalistic 360° video, but we also explored how new immersive medias compare to more traditional ways of consuming news and information. In the experiment, each participant experienced the content in different media forms: as audio only, as a 360° video viewed on a mobile phone, or as a 360° video viewed with a VR headset. All participants also read the original article in digital print form. In this way, we hoped to understand how the experience differed across the three medias, and which media(s) users prefer in the context of news consumption.

The testing was conducted in a laboratory environment with a total of 30 participants (see Figure 7, left, for an example). Each participant first experienced two out of the three types of media, then all participants read the original article on a laptop. Participants filled in a questionnaire after each media, as well as a final questionnaire in which they compared their experiences. Finally, a short interview was conducted to further understand the participants' thoughts about the experience and the reasoning behind their preferences.

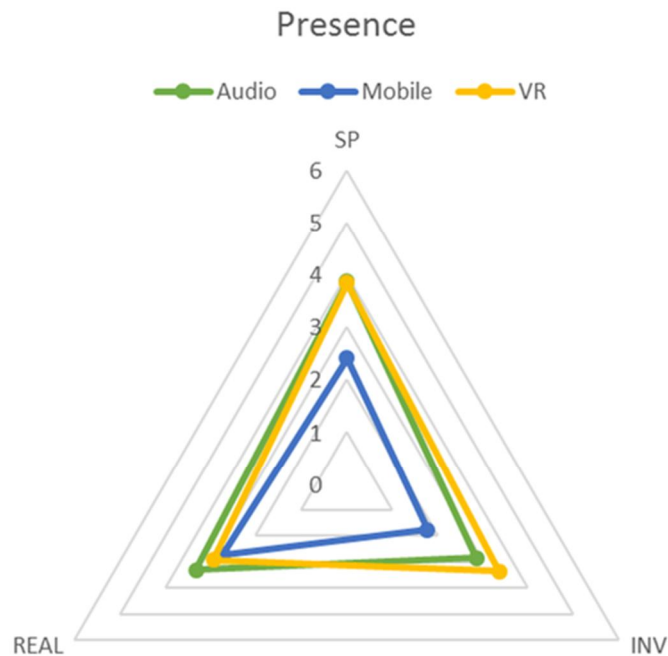


Figure 7: Left: An example of the testing set up. Right: The presence scores for realness (REAL), spatial presence (SP), and involvement (INV) according to media group. (Igroup Presence Questionnaire by Schubert et al., 2001)

The data are still under analysis at the time of finalizing this booklet, but a few preliminary points can be made based on the analysis thus far. Firstly, one experiential element that was measured was presence. In short, higher presence was reported in the VR and Audio only experiences, while the Mobile phone experience had the lowest reported presence (Figure 7, right). In terms of other experiential elements, the article experience outperformed the other forms of media in reliability, interest, attention, understanding, recommendation, and enjoyment. However, the Audio only experience was reported as more informative and slightly more pleasant than the other experiences. Finally, in terms of preference, the medias were ranked as thus: 1. Article, 2. Audio only, 3. VR, 4. Mobile Phone. This begs for discussion in how effective virtual reality really is in terms of delivering the news experience. However, the experience is assumedly very sensitive to the news type and the content in general.

The interview data is still under analysis and no final conclusions can be made about the findings yet. However, it is still interesting to consider a few comments made by the participants, at least taken as they are, comments, and not necessarily indicative of the final results:

§ Virtual Reality:

- *"Well that [VR experience] was exciting. I've never tested anything like that."*
- *"Maybe [I would prefer] a topic that would've been more experiential. That's what I would assume HMD to be used with..."*

§ Audio only:

- *"The audio, listening, felt the most pleasant way to get this kind of information..."*
- *"I was able to concentrate more in the audio version than the VR version."*

§ Article:

- *"In my opinion this [article] was the easiest way to approach the topic as I'm used to reading articles, and especially Helsingin Sanomat articles are quite pleasant to read. Maybe kind of the easiest way personally to approach the topic is when I read it..."*

As the comments show, a VR experience can be very exciting if the user is yet acquainted with VR; however, as the second comment suggests, VR brings such high expectations that a simple informational experience is not enough to fully engage users. Additionally, the preliminary results of a high presence score and second place in preference for the audio experience, might suggest that podcasts or audio experiences are another avenue that journalists should not ignore or neglect. In creating new forms of media, the journalistic content should be analyzed in terms of fit for the type of media to which it should be adapted. The novelty of VR is not enough on its own to make a great experience; the content itself must be appropriate for the virtual context, otherwise, other adaptations or medias should instead be explored.

Read more & references

Schubert, T., Friedmann, F., and Regenbrecht, H. 2001. The experience of presence: Factor analytic insights. *Presence: Teleoperators and Virtual Environments* 10, 3: 266–281.

Case *The Finnish You*

Airports are chaotic and busy environments that require people to adjust to their temporal organization and follow specific procedures. Furthermore, the whole airport experience may be viewed as a process of constant waiting until you can board your flight, and if not utilized, can affect the overall traveling experience negatively. Thus, there is a need to accumulate positive and meaningful experiences to, not only utilize the waiting time, but also connect travelers to local culture and shopping activities.

To address these needs, we set a goal to explore *how interactive storytelling approach can be utilized to engage travelers in a cultural learning shopping adventure* at the airport and what are *the strengths and constraints* of such an approach. To answer these questions, we designed and developed a web-application, *The Finnish You*⁵, which guides travelers through Finnish brands and shops at the Helsinki airport while learning about Finnish culture and lifestyle via personalized storytelling.

The storyline is unique to every user and it is generated based on the user's background data (age, gender, personal preferences). The storyline illustrates what the user's life might look like, if the user had been born in Finland or, in other words, it tells a story about the user's Finnish persona. There is a short introduction story consisting of a Finnish name and its meaning, place of residence in Finland and a general overview of one's life style, meaning things like workplace, pets, and free-time activities (see Figure 8, left).



Figure 8: Left: An example of the Finnish persona. Right: An example of an invitation to a Finnish event.

⁵ The application can be accessed at <http://finavia.uta.fi/> on mobile devices.

To create a context for shopping activity, the application generates an invitation to a purely Finnish event (see Figure 8, right), and afterwards randomly suggests visiting Finnish shops in the airport to buy a specific product for an event (see Figure 9, left). Such a strategy is used to persuade travelers to visit the Finnish shops and transparently advertise Finnish products via short narratives and brand stories. The user may also select the shop they want to visit, or check which shops they have visited already, from a map of shops (see Figure 9, right).



Figure 9: Left: An example of a product suggestion to be bought for the Finnish event. Right: The map of shops view.

The navigation to a shop is the user's challenge for a few reasons and the application only provides a gate and floor number. First of all, indoor navigation is not yet a feasible technology to rely on. Even if it was, we want the users to explore all shopping activities and look around rather than keep looking into their phones. After the users have visited all of the (eight) shops, or need to leave, the application presents the summary story segment, including more culture-specific information, an overview of the shopping activity, and a summary of the Finnish event. The final story may be uploaded to the user's portable device or shared on social networks as a pdf file.

Evaluation

To evaluate the Finnish You for shopping experiences at Helsinki airport, we have conducted two user studies with different agendas. The first study was held in an office environment simulating an airport shopping area and focused on user experience, user satisfaction, and storytelling content. The procedure consisted of a pre-questionnaire (background data + shopping habits), the simulated a shopping adventure with a scenario and a set of tasks, a post-questionnaire, and an interview. We had 9 participants of various non-Finnish nationalities (the majority being Chinese) aged 20–30 years ($M=25$).

We found that the idea of using a storytelling application was perceived positively and was seen as a satisfactory way to utilize waiting time at the airport. The application was found to be user-friendly and easy to learn. However, some of the users found it difficult to understand the purpose of the application and expected to see another kind of purely shopping application. We also identified challenges in the personalized digital storytelling approach: For example, we realized that reading as a process cannot engage everyone and other methods of digital storytelling should be used with an emphasis on visuals. We further found that the feeling of being related to a story character may increase the interest towards the story and the shopping adventure themselves, and on the contrary. Based on the first study we created a set of guidelines for the design of a storytelling application, and they are as follows:

- § Multiple methods of digital storytelling should be utilized with an emphasis on visuals.
- § Storytelling content should be personalized to the extent possible.
- § Avatars should be customizable or generated based on the user's appearance.
- § Extrinsic motivators should be utilized and presented to the users in the very beginning.
- § Various playful activities and socialization factors should be used to increase intrinsic motivation.

Our second study was conducted in the Helsinki airport with real air travelers. The focus of the study was to observe how travelers use the application in the airport context and how the application affects the waiting time and shopping behavior. We let our participants to freely explore the application and observed their actions. After a little shopping adventure (2–3 shops visited), we asked the participants to finish and find the summary of the shopping adventure. Then, we asked them to fill in a short post-questionnaire and respond to a few interview questions, mainly to collect opinions and ideas on how to make the application and the experience better. We had a total of 15 participants with different nationalities (the majority being Chinese and Russian) and aged 19–45 years ($M=27$).

The idea of a personalized storyline in an airport context was considered to be *novel, interesting and engaging*. The participants reported that the application helped to notice shops they would not see without it. One of the participants even commented: *"It set my attitude to explore more"*. However, considering the high cognitive load at the airport, most of the participants skipped the description of the application and needed help from the researcher in some parts. Thus, we suggest using transparent in-story instructions to describe how to use the application instead of providing instructions in the very beginning. Moreover, we found the participants to be interested in seeing more products in the application, so we propose adding catalogs and pop-ups with the product of the day or season, or discount products.

To conclude, digital personalized storytelling is a suitable strategy to utilize waiting time at the airport and to connect passengers to local culture and local products. With this project we took the first step on using story generation method to engage travelers and illustrate the cultural specifics in chaotic touristic environments, like airports.

Read more & references

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2. Lean UX design approach applied to immersive journalism

Chelsea Kelling, Heli Väättäjä, Otto Kauhanen (IHTE, TUT)

Creating an experience for virtual reality can seem daunting: visuals should be pixel perfect, heavy programming might be needed, and users should be somehow wowed by the end result. Additionally, there are often many stakeholders involved in projects, and collaboration can be slow and arduous. However, the creation journey does not have to be so complicated, and there are in fact lean design principles that can be applied that allow an agile design process. In this portion of the VIRJOX project, we present our research collaboration with a Finnish news media publisher and offer our lean design thinking-based approach to exploring VR storytelling and prototyping in the field of journalism. The major contribution of this collaboration focuses on ideating, building, and testing VR journalism prototypes. We also explored immersion and presence in VR journalistic storytelling, as well as the impactful user experience elements for the VR experiences.

The world of journalism is fast paced and results driven. As new types of technology and medias are brought into the field, a learning curve slows their integration and can cloud potential, especially in organizations that are reluctant to change. To combat these barriers of entry, we aimed to examine how an agile design process could be introduced in a journalistic context with the creation of a cultural VR application. Working with stakeholders such as media representatives, a local museum, and users themselves, we applied the Lean User Experience (UX) Design process to create a biographic 360° experience for a Finnish artist Hugo Simberg and his most famous and beloved painting the Wounded Angel. The design process is presented in Figure 10. Consisting of small and rapidly moving iterative steps, the process is well suited for fast-paced creation contexts, like in journalism.

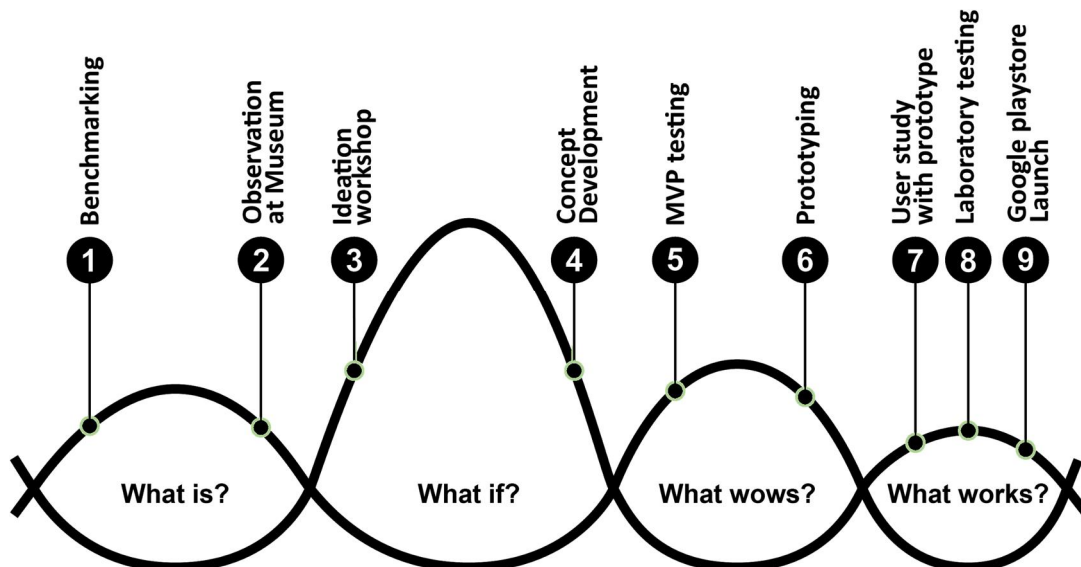


Figure 10: Lean User Experience Design Process (adapted from Liedtka, 2011).

In our research example, we started by benchmarking existing solutions that resembled what we wanted to create. For example, we examined *Boulevard* (Boulevard, 2017) to better understand how the museum environment could be recreated, *Night Café* (Borrowed Light Studios, 2015), where the user can go into a painting by Van Gogh and explore it, to gather ideas about how museums can be experienced from a different perspective, and finally *We Wait* (BBC, 2017), which tells the story of Syrian refugees in a unique low poly visual style, to try an experience in which the audio and narration greatly contributed as storytelling elements. It was important to understand what was already out there, what was lacking, and what could be a valuable addition to our own solution. Next, because our subject matter centered on exploring a museum, we did observation sessions at an actual museum to better understand how the environment exists in the real world, and how individuals acted in the space. After the background information was obtained and analyzed, we moved onto the brainstorming stage. Here, we held workshops both with the media project partners and potential users. The ideas from these workshops were then narrowed down according to their fit in our research context, associated technical restrictions, and potential to bring value to stakeholders.

Once the concept was chosen, we began prototyping. Prototyping in VR holds many of the same benefits as prototyping with other technology, for example mobile phone applications: it allows the collection of feedback and evaluation metrics without wasting time or resources. In our case, we even began with a paper prototype; we sketched out the different scenes to plan what should be included, and tested out icons that could be used. In the next part of the first iteration, we identified the experiential aspects which were most important to get started with, and came up with a plan for a minimum viable product (MVP). The MVP acted as a starting point for the concept, in which we could create a prototype that included only the necessary bones, yet at a level that would still bring the maximum amount of value to all those involved. This allowed us to begin testing the idea quickly, without heavy developing or time-consuming preparation. The next phase was a cycle of iterative prototyping and testing; once the MVP was created and tested, we added small improvements identified by potential users and feedback from the media company, tested again, then made improvements. The end result was a well-tested, fully functioning VR application, *the Hugo Simberg VR*, which can now be downloaded from the Google Play Store⁶. (More information on the application can be found above in chapter 1, section *Case Hugo Simberg VR*.)

For this case, we found the lean process to be highly functional and well suited. By gathering feedback from users and stakeholders at every stage of the process, especially early on, we eliminated the risk of running into larger potential issues further down the line. Implementing full fledged VR applications can be very resource-heavy, and if a mistake or design flaw is not identified until the implementation is already finished, the issue can take twice as long to correct than if it had been discovered in the early stages of design. Additionally, VR is still an experimental field in the sense that there is much to be discovered in terms of experiential potential. Applying a lean approach to the design process is a great way to explore new ways of creating memorable experiences and then collecting quick user feedback through rapid prototyping.

⁶ Hugo Simberg VR can be found with its name on Google Play Store or downloaded through <https://play.google.com/store/apps/details?id=fi.uta.coms.tauchi.hugosimbergvr>.

However, not all stakeholders will be willing to jump on board this lean design thinking approach. In our case, the media company was highly collaborative and excited to explore this new way of creating media. This may not always be the case, especially if the company is not normally an early technology adopter or not familiar with the benefits of agile creation. If so, it is important to fully explain the advantages described above to stakeholders, highlighting the worth that comes from minimizing resources and maximizing the value and impact through iterative design and prototyping.

Although our experiences indicate a positive outcome when using lean design approaches for VR, more work is needed to expand on the creation process and further explore what tools can be utilized both in the field of journalism and VR creation in general. Based on our experiences within this project we strongly believe that lean approach helps in experimenting the ideas quickly, gaining feedback on the experiential aspects important for supporting the storytelling and immersive experiences, and moving effectively towards the implementation.

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3. UX dimensions in immersive journalistic storytelling

Chelsea Kelling, Heli Väättäjä, Otto Kauhanen (IHTE, TUT)

The potential of immersive journalism promises users a deeper look into their world than ever before. However, although VR is becoming more and more mainstream, there is a large gap of understanding between what makes a memorable experience and what makes a terrible experience. Even more interesting, is what makes the very small difference between an okay experience and a great experience in VR, especially so in the journalistic context. What can content creators and journalists do to be sure their users are engaged with the story, emotionally involved in the narrative, and can't wait to tell their friends about the amazing experience they had in VR? As VR becomes more well-known, the novelty of the technology will quickly fade and the finer details of the experience will be what differentiates a poor product from a well-made product. These details are what we sought to uncover.

To understand the underlying elements that support a positive user experience in VR, we conducted several in-depth user studies. Through questionnaires that focused on different aspects of the experience, such as emotional reactions, sense of presence and immersion, and basic usability, as well as post-test interviews, we were able to identify a set of themes which occurred frequently across the studies. Gathering data in both questionnaire and interview form allowed us to first identify the positive and negative reactions, then look deeper into the meaning behind them. After the data was gathered and recorded, responses were sorted first into small categories and then further organized into larger themes (see Figure 11). As more and more data was sorted, it became evident that there were some factors of the experience that depended largely on other parts of the experience.



Figure 11: The initial affinity wall where interview data was sorted into categories.

In the 1940s, Abraham Maslow (1943), one of the most influential psychologists of the 20th century, introduced his now well-known Hierarchy of Needs. The model is displayed as a pyramid and describes what humans need to first survive and then thrive, with the most basic needs such as food and shelter at the bottom of the pyramid, and the more complex and abstract human needs, such as self-actualization, at the top. Although Maslow's pyramid is not without flaws, it is a good example of how needs are not independent of each other, and in many cases the needs at the bottom of the pyramid must be fulfilled before the needs at the top can be reached. Similarly, Jordan (1997) presented a rather simple Hierarchy of User Needs, in which users must be able to find Functionality in a product first, then Usability, and

finally they can experience Pleasure. Building upon these two examples, we found that our data made sense in a similar way.

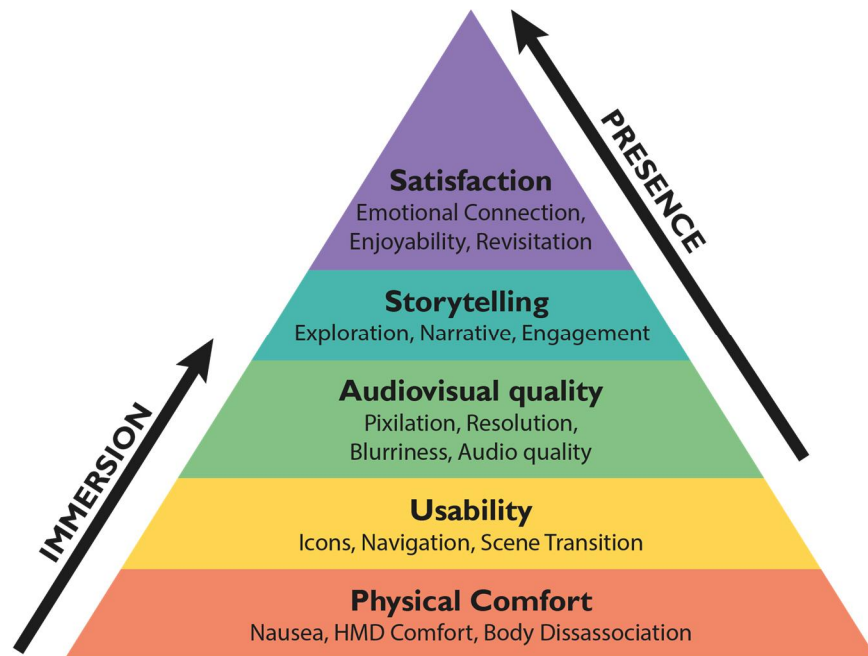


Figure 12: Hierarchy of Needs for User Experiences in Virtual Reality.

In Figure 12, we present our Hierarchy of Needs for User Experiences in Virtual Reality. At the base of the pyramid, you find the basic physical aspects that can affect the VR experience. If a user experiences motion sickness or is distracted by an uncomfortable headset, then the whole experience will be thrown off course. Next, many user comments centered on the actual usability of the application, such as being unable to navigate the space correctly, and the audiovisual quality, such as sound level and image pixilation. Again, if the basics of the experience are not satisfactory, then the more abstract goals of the experience like being involved in the narrative cannot be achieved. Storytelling sits on the pyramid second to the top and includes the ability of the experience to encourage exploration of the virtual environments and create deep engagement with the users. Because our studies examined VR applications used in journalistic contexts, storytelling becomes even more important because of the narrative nature of journalism itself. Without a story, users will be more unlikely to view the entire experience and possibly even more likely to lose motivation to return to try similar VR experiences. Finally, at the top of the pyramid lies user satisfaction. To achieve full satisfaction in their experiences, users will have had to fulfill all the previous levels of the pyramid. If so, end goals such as low user attrition and strong emotional connections to the content is more easily attained. Additionally, the influence of immersion and presence is also going to affect several layers of the pyramid. On the left side of the pyramid, immersion grows as the more objective qualities of the experience increase, while presence also increase as the more subjective needs are met.

This model aims to aid not only immersive journalists, but also VR researchers, designers, and more widely, content creators in other industries. It is time to put away the roller coaster demos and give users experiences that are truly captivating and meaningful. Through careful consideration at each stage of a

well-crafted experience, this can be achieved. It is also important to consider how our model can be taken further and expanded; for example, elements such as context of use or the individual differences within user groups should also be included in design considerations.

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4. Immersive journalism as storytelling

Esa Sirkkunen (COMET, UTA), Turo Uskali (JYU)

Journalists have always tried to create the most realistic representations possible. In this sense, VR offers perhaps the most effective medium for journalists to replicate the effect of 'being there' for audience members and VR users (Sirkkunen et al., 2016). The most advanced VR headsets and controllers allow for a full range of interactions in virtual environments. 360 videos (or spherical videos) are much more limited in terms of interaction; they capture an entire scene in which users can look up, down and around. However, 360 video is still a big step towards immersive 3D experiences. Cheap headsets for 360 video (such as Google Cardboard) are currently the most popular devices for using 360 video, which is why some newsrooms have started to experiment with 360 video journalism. In the VIRJOX-project we have explored, what are the main features 360 video journalism (Sirkkunen et al., 2017a) and what kind of narrative means and production models have been used in the 360 productions so far (Sirkkunen, 2017b).

Genres of 360 journalism: from live to documentaries and fiction

The tentative genres of 360 journalism that we analysed seem to at least loosely follow those used in journalism in general. There seems to be a separation between hard news (short on location reports), documentaries (longer, more complicated narratives), and fiction (experimenting with elements of drama and 1st-person narratives). Tentative genres found from our sample are 360 live streaming, 360 video news, 360 video documentaries, and 360 video fiction (see Figures 13–16).



Figure 13: 360 live streaming, used in NBA games, concerts, political rituals like for example president Trump's inauguration. Also user generated content such as 360 live streaming in YouTube, Periscope, and Facebook is becoming popular.

Figure 14: 360 video news, duration 1–3 minutes, visiting distant places, showing wonders of nature, art exhibitions, visiting war zones and refugee camps. Often used journalist's voice-over narration or reporter on the spot reporting. Quite often there is no vocal narration at all like in the New York Times Daily 360 news.

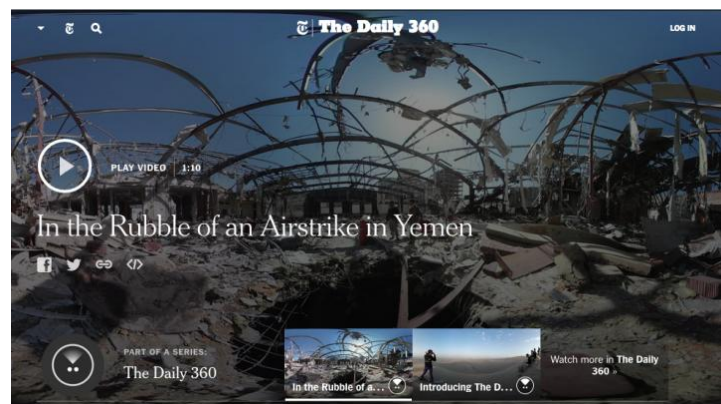




Figure 15: 360 video documentaries, duration 4–20 minutes, often aimed at creating empathy or other emotional response, various narrative strategies in use, some are avoiding photo realism using animated characters.

Figure 16: 360 video fiction, mostly produced by the New York Times. A good example is *Lincoln in the Bardo*, a 360 video version of the novel by George Saunders or *LA Noir* short stories in which user is no casual observer but a character in a bar of 1940's Los Angeles.



We have found some interesting content trends in 360 video journalism. First, live 360 video news and short 360 video news rely on the VR effect that 360 video affords – users can experience the story themselves. The short 360 video news have been the most popular genre in VR journalism so far. The most active newsroom is the New York Times which has produced in 2016–18 351 short 360 video news pieces, following Euronews with 140 pieces. Second, the longer and more developed 360 documentaries are more versatile in terms of narrative structure. Journalists in this case clearly have had more freedom to explore ideas outside of standard journalism (e.g., concepts and techniques from other genres, such as gaming and movies). Ultimately, our findings indicate that 360 journalism not only recycles ideas from previous genres of journalism but is also paving the way towards new forms of narration and expression that are about witnessing, experiencing and understanding news and other stories in a novel way.

Production becomes lighter and easier

We asked professionals (N=11) from the US, Great Britain, Finland, and Sweden producing journalistic VR about the core features of VR journalism. Our interviewees stated that the ability to offer a strong sense of presence is the key to understand what kind of themes and topics should be presented in VR stories. Another important feature is whether there is something to experience viscerally, with our senses. Third important feature is the possibility to show the world from a new angle and possibly from first-person point of view.

When talking about the most important narrative features of VR, our interviews showed that avoiding conventional narration is the key to immersive experiences. The user should have the freedom to hover in the virtual space as she or he wants. This means that there may not be a narrative at all or that there must be several ways of navigating in the story. In the more complicated stories, the writing process resembles more the making of a game than conventional news narrative. Sound, and if possible, touch are at least as essential senses as the visual information of a story.

However, the production of VR content is still in its early phase and the work practices are still evolving. Already, according to our interviews, we can claim that the production of VR documentaries particularly have evolved from labor intensive model, where over 50 specialists created a VR documentary (see for example *The Displaced*, the New York Times, 2015), into a lighter teamwork, of just 2–3 professionals. The amount of staff depends on the general strategy and the resources of the organisation. For example Euronews (with a sponsorship of Samsung) has been able to make substantial amount of short 360 video news with relatively cheap equipment and with only short introduction on the making of 360 video. On the other end there are expensive documentaries that have taken months of processing.

Questions of ethics on the rise

There is a growing concern on how the psychic consequences and risks of VR should be dealt with in the future. There seems to be a consensus among most of our interviewees that the users should be warned in advance about the possible traumatizing content. There are open questions like are the disclaimers enough how to prevent sensitive users to become traumatized, what are the codes of representing reality in journalistic VR, and how advertising and for example production placement should be dealt with in these surrounding.

Also, other so called bottlenecks for VR journalism were detected, especially the lack of audience. VR as a new technology has not yet penetrated into the mass markets. In addition, the dissemination of VR content is difficult for the newsrooms because of the different competing platforms and technologies. This is why many experts were cautious of VR journalism's near future success. Actually, for example augmented reality (AR) was seen as more promising new tech for journalism by some of our interviewees.

Of course, more audience research and usability research is still needed. The whole VR industry has been hyped so much that there is clearly a need for a reality check. There is also a need for systematic audience research in order to know what are the possibilities of VR becoming the next mass medium and VR becoming an important tool for journalistic storytelling.

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5. Drone journalism: From marginal to mainstream

Turo Uskali (JYU)

The use of camera drones in journalism started in year 2011. The first aerial news footages were based on either Do-It-Yourself models of drones or lightweight commercial drones like AR Parrot. The first users were freelancers and activists participating demonstrations in Warsaw, Poland, or Occupy Wall Street demonstrations in the United States. Another early category of news events, where drones were used, were floods. In this way, we can argue that drone journalism started from crisis reporting.

Along product development procedures and incremental innovations, the drone models got better and more reliable. Adding new safety features like geo-fencing and collision preventing systems, and improvements in the battery life have enabled more newsrooms around the world to adapt drones in their work practices. In hindsight, we can define the years 2011–2015 as pioneering periods of drone journalism and the years from 2016 onwards as drone journalism going main stream.

Responsible drone journalism

Using drones for journalistic purposes needs special skills and knowledge about rules and ethics. The Aviation Legislation gives nowadays the basic rules for drone activities in many countries. For example in the United States, since 2016, the FAA has demanded a special license for all those using drones for commercial purposes, including news business. However, the rules and practices are still much discussed in many countries, including the United States. In addition to general aviation rules, journalism ethics apply also in drone journalism. Privacy especially has to be respected by drone journalists. Also, it is advised to not fly over big crowds or during the night time. Furthermore, it is important that the drone operator has always the direct eyesight to the drone.

In the beginning of the era of drone journalism, paparazzi-photographers made headlines, when not respecting the privacy rules. In some cases, like in Switzerland and South-Africa, the drones were confiscated and also the photographers arrested for a while.

Responsible use of drones in journalism is the best way to safeguard that the drones will be in the toolbox also in the future. It is also important to develop effective modules and courses for drone journalism education. In the University of Jyväskylä, responsible drone journalism has been in the curriculum since 2015. The drone journalism course (3 cu) now includes both theoretical and practical drone piloting tests. This kind of drone piloting test model is also currently planned in the European Union, which aims at opening a special airspace for drone operations during 2020's, called as U-space.



Figure 17: Drone piloting tests at the sport fields at the campus of University of Jyväskylä in 2018.

During the VIRJOX project we tested the use of 360-cameras in drones, but we had to quit testing because of unstable maneuvering and constant threats of losing the drones or crashing them. In this respect, the drones need still to be developed further. Also poor weather conditions prevented and postponed the test several times. We tested the use of drones also in breaking news situations, but, once again, with poor results. We were not able to get to the minor accident sides fast enough with our cars. In conclusion, it seems that the use of the drones should be automated in order to be used in breaking news situations.



Figure 18: Tests in breaking news situations in winter 2018.

Three scenarios for drone journalism

In collaboration with the ViSmedia project at the University of Bergen, we have created three scenarios for the drone journalism: 1) drones everywhere, 2) total ban of drones, and 3) drone mosaic.

It is totally possible that drones will become ubiquitous gadgets in societies. They are used, not only by journalists, but other professionals and also hobbyists. This scenario is called as drones everywhere. If the marketing by drone manufacturers is going to be any reliable hint of the future, in every family will be a drone sooner or later. This scenario is also supported by the European Union, which is currently planning a special airspace for the drone operations.

The second scenario is based on an assumption that all uses of drones could be banned. This is the so called scary scenario. Total bans of drones already exist in some parts of the world, especially in certain authoritarian countries. Also in open democracies drone bans or heavy restrictions could be possible, like in Sweden in 2017–2018. Even just one fatal incident or just a hint of a security thread could put all drone operations on the hold in a country.

The third scenario is based on interpretation that there will be different level of restrictions and even total bans for the use of drones in the future. Actually, this kind of spectrum already exists, when looking the drone rules globally. In this respect, for example the Nordic countries have quite liberal drone rules and therefore could be in the forefront in testing and innovating the use of drones in many industries.

In the future, for example in breaking news situations, drones could be always the first cameras on the spot to report safely and timely about what has happened. In order to fulfill this vision, more automation and other technological developments should occur. Drone journalism still needs plenty of technological and social innovations, better technological infrastructures and legal frameworks, in order to become ubiquitous practice in the newsrooms globally.

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6. Creating and communicating value in VR/AR solutions

Ilona Ilvonen, Joel Vanhalakka (Knowledge and Learning Research Center, TUT)

Value in business is often considered self-evident. In this work package this self-evidence was challenged, and value examined from different, sometimes subjective, viewpoints: who is value created to, who participate in this creation, and what new possibilities do AR/VR offer to existing value creation and business models. Multiple interviews with VR/AR experts from different industries were conducted to gather understanding of the maturity of value creation with VR/AR tools, and the communication of value potential within and across industries.

To examine value creation in AR/VR, the Business Model Canvas (BMC) (Osterwalder and Pigneur, 2010) was used as an analytical and communication tool. Different cases from multiple industries were analyzed to gain understanding of the value creation potential of AR/VR solutions. The BMC below illustrates the main findings of the comparative case studies.










<p><i>Key Partners</i> </p> <p>Most important partners:</p> <ol style="list-style-type: none"> 1) VR/AR experts / game developers 2) VR/AR industry key players such 3) VR/AR content creators 	<p><i>Key Activities</i> </p> <p>Key activities:</p> <ol style="list-style-type: none"> 1) Research and development 2) Marketing 3) Content development 4) Technical support <p><i>Key Resources</i> </p> <p>Key resources:</p> <ol style="list-style-type: none"> 1) IP 2) Technology 	<p><i>Value Proposition</i> </p> <p>Four themes of VR/AR value creation:</p> <ol style="list-style-type: none"> 1) Engagement & experiences 2) Eliminating complexity from interaction 3) Reduce costs 4) Improve communication and collaboration 	<p><i>Customer Relationships</i> </p> <p>Personal when required and automated when possible.</p> <p>VR/AR can offer new ways to collect customer metrics.</p> <p><i>Channels</i> </p> <p>Lacking specialized application ecosystems and open platforms. Pre-existing channels lack differentiation.</p>	<p><i>Customer Segments</i> </p> <p>Four customer groups:</p> <ul style="list-style-type: none"> • Mass markets for mobile VR/AR devices <p>High-end devices:</p> <ol style="list-style-type: none"> 1) Gamers 2) Professionals 3) Enterprises
<p><i>Cost Structure</i> </p> <p>Recurring key cost structure elements are research and development, marketing, content development and technologies.</p>		<p><i>Revenue Streams</i> </p> <p>Still explorative in mass markets. More consistent streams of VR/AR direct revenue come from professional/enterprise solutions.</p>		

Figure 19: A summarization of the business model findings (Vanhalakka, 2018).

The nine building blocks of the business model canvas (value propositions, customer segments, channels, customer relationships, revenue streams, key partners, key activities, key resources and cost structure) are all considered as parts of an enterprise's value creation process. One of the questions that came up during this study was whether the value of VR/AR solutions could be summarized on a business level, or whether the value or the value propositions the technology proposed were too complex and would suffer from over-simplification. As the study progressed, it was noted that the process of taking these complex value propositions and condensing them into aggregated concepts in the business model canvas was often

advantageous for analyzing value creation, as it revealed the connections between the different sections. The compression of these ideas highlighted that the products and their value propositions are only a small part of the value creation process. Comparison across industries was easier to do with the whole BMC canvases, instead of comparing only the value proposition statements.

One of the reasons behind this study was to create a separation between the facts, the heightened expectations and the hype concerning the technologies. During the making of this study, the technologies of VR/AR have taken big steps forward. The technologies are becoming more common and more available, and new big players have entered the market. The development indicates that VR/AR can become more commonplace faster than what the original forecasts of, for example, Gartner (2016) and IDC (2016) predicted. The technologies of VR/AR can be used to create new products and services, and to leverage existing ones. While the technologies are not yet ready for mass consumer markets, enterprises should begin to prepare themselves for the time when they do, as it will become a key source of competitive advantage for many. Various communities have been developed around the VR/AR technologies, and these communities are important platforms for companies across industries to share experiences and use cases of the technologies. However, benchmarking across industries needs to be done carefully and regarding the role of the technology in the entire value creation process: whether it is a factor that adds costs but adds income (e.g., journalism) or whether it reduces costs or changes the cost structure (e.g., construction) are for example situations where benchmarking might prove difficult between companies.

The BMC is above all a tool to communicate value. It is fitting that in a project that focuses on storytelling, even the value communication tool has narrative elements. In the interviews of different VR/AR experts it was found, that telling the “business story” of a technology solution by filling the BMC section by section is an effective way to identify and communicate value. The story begins from the center of the canvas with the value proposition statements, and continues then by filling the other fields in an order that best serves the purposes of the solution at hand. This narrative approach helps to identify the creators and receivers of value, as well as the supporting functions that are required for the value to be created.

For example, in the airport story, *The Finnish You*, value receivers are not only the passengers using the application, but also the shop owners that gain a new vector to communicate with potential customers. There are thus two value propositions to the application: enhanced airport experience and new ways of communicating with passengers. Success in realizing the value potential requires the participation of the shop owners to the development and use of the application, as well as a well-functioning technology platform and support for it.

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