VR of the Future
— A Case Study of Nokia Corporation

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Laurea University of Applied Sciences **Abstract**

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VR of the future

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This thesis is done in collaboration with Nokia. The team was given a challenge to ideate a future arena experience, and to imagine how could the event industry change within a next three to ten years.

The thesis focuses on the future usage of virtual reality (VR) in event industry. Virtual reality can either aid to stimulate some real environment or it can create a completely imaginary environment using three-dimensional objects. It is a widely studied matter that is being used in multiple ways, and the thesis focuses on standards and theories needed to implement VR in the event industry.

The project for Nokia was done as a team that worked tightly together in a design sprint for a week. With the help of different design sprint tools like brainstorming and sparring, the team generated an idea of a way to use virtual reality glasses in an event industry as a completely new type of arena experience. The idea was to create events at the arena that feel like they are happening right in front of the audience even when they happen, for example, on the other side of the world, or are completely virtual, and to make seeing said events from home feel more interactive.

At the end of the week the team presented the idea for Nokia, with a conclusion that this type of event does not exist yet, and with an all-new concept Nokia could increase the number of customers and become a trendsetter for the future of the event industry.

Keywords: Virtual Reality, Future, Nokia

Content

1. Introduction

At the design sprint - thesis kick-off meeting the team was tasked to choose an objective between “next generation stadium”, “network-as-Code for Nokia arena” and “Network-as-Code anywhere”, and chose next generation stadium. The purpose of the design sprint with this task was to envision and create a concept for a next generation arena experience. The team thought that adding augmented reality (AR) and mixed reality (MR) to the Nokia arena events, as well as giving the customers a chance to attend events from home with virtual reality (VR), would be a great concept for Nokia.

The team’s objective was to envision next generation arena and to come up with new and innovative ways to utilize virtual reality (VR) in Nokia arena. The team came up with event concepts that would utilize virtual reality (VR), augmented reality (AR) and mixed reality (MR). For example, one of the team’s concepts include a fully virtual event that you can watch with VR glasses at the arena, or you could rent VR glasses from the same place you get your tickets and watch the virtual show at home.

2. Nokia

Nokia Arena is a new event arena located in the heart of Tampere, opened in 2021. The event centre offers arena services, a top-class hotel, an international casino, diverse event facilities, as well as several restaurants for its guests. (Nokia Arena 2022.)

The arena has about 15,000 spectator seats and has visitors over 1 million people per year. The facilities cover 50,000 m2 and the arena uses state-of-the-art technology, enabling event organizers to host large, memorable, and diverse events for their clients. (Nokia Arena 2022.)

Nokia as a Corporation creates technology that helps the world work together. The company provides consumers with technology and equipment, meets the online service needs of communications service providers, industry and the public sector and offers innovation and brand-based licensing. The company was originally founded in 1865 and the current CEO is Pekka Lundmark. (Nokia 2022.)

The Company’s net sales in 2021 amounted to 22,3 billion euros, with an operating profit percentage of 9.50 % (Kauppalehti 2022). Nokia is a large international company with operations in up to 130 countries, Finland alone has about 6500 employees (Nokia 2022).

Laurea University of Applied Sciences and Nokia Corporation have agreed on a key partnership. The purpose of this collaboration is to implement joint projects from which Nokia can get new ideas and students gain practical experience in project work, as well as create something new and innovative. Nokia also wants to inform students of future work opportunities at Nokia. (Laurea 2022.)

In the Design Sprint thesis project, Nokia's task was to provide the teams with problem options, from which the teams chose their target to develop. During the Design Sprint week, Nokia staff acted as sparring partners for the teams, helping with problems, giving encouragement and new ideas for the development of the project.

3. Design Sprint as a concept

Design Sprint is an effective way to develop services and products. The five-day project (figure 1) will determine the baseline and the challenge to be solved. During the week, a solution will be brainstorming together with the customer and designing a concept to build and test a prototype. This efficient way of work can condense up to months of work into one week, thus turning a new idea into concrete and testing quickly. Design Sprint also reduces the risk of a new service or product when a product is tested early in development. (Hurja 2021.)

Figure 1: Design sprint week

Day 1: Identify the baseline situation and define the challenge to be solved. Involves a lot of discussion and the creation of a concept to be developed. (Hurja 2021.) The first day is vey structured. In the morning, key questions and the long-term goal is defined, then a simple map of the product is created, and last a target is chosen. Target is a fixed point on the map of the product, that shows the greatest risk or opportunity. The structure helps the team to get to work very quickly. (Knapp & Zeratsky 2022.) During our design sprint, Nokia had already chosen the target points and all we needed to do was to choose a target best suitable for the team.

Day 2: On the second day, the focus is on ideation and the selected ideas are visualized (Hurja 2021). The day is all about solving the problem with different methods (Knapp & Zeratsky 2022). The team already started this part on the first day with brainstorming the ideas.

Day 3: A decision is taken to further define the scope of the development. Conduct background research on the customer and end users. (Hurja 2021.) By this time there should be a stack of solutions, and not all of them can be prototyped. At this point, it is necessary to decide which ideas to take further. Then in the afternoon is a sketching phase, where a storyboard for the teams plan for the prototype is created. (Knapp & Zeratsky 2022.)

Day 4: Create a realistic and visual prototype (Hurja 2021). On the fourth day, the prototype for the product is created. This should make the product feel as real as possible, to convince the customers. The prototype can be anything form visualisation to an actual demo of the product. (Knapp & Zeratsky 2022.)

Day 5: Test the prototype with the customer in different applications and present the final result to the customer and make plans for further development (Hurja 2021). While presenting the idea, customers reactions should be watched to know how they really feel about the product, to have a realistic idea on where to go next (Knapp & Zeratsky 2022).

In chapter 4, we discuss how the team used the Design Sprint model in the project.

4. Virtual reality

Virtual reality (VR) is an artificial environment created with the help of sensations produced by computer simulation. Virtual reality can either aid to stimulate some real environment or it can create a completely imaginary environment using three-dimensional objects. (Iberdrola 2022.) While the VR industry is still far from realizing the vision of totally immersive vitual environment that would enable users to engage multiple sensations, the technology has taken big steps forward in providing realistic sensory engagement and is already used in number of industries (Sheldon 2022).

There are three primary categories of virtual reality simulations used today: non-immersive, semi-immersive, and fully immersive simulations (Figure 2). Non-immersive simulations are often not considered virtual reality, as it typically refers to a 3D simulated environment that is commonly accessed through a computer screen. The environment might also generate sound, depending on program. The user controls the environment using a keyboard or a controller. One example of this type of VR are video games. Semi-immersive simulations give

the users perception of a different reality, but the users still stay connected in their physical surroundings. This is often done through a computer screen or some type of glasses or a headset. It focuses mainly on the visuality and 3D aspects rather than the physical movement. This type of VR is often used in training purposes, such as airlines flight simulators that are used to train their pilots. And finally, fully immersive simulations provide users the most realistic experience, with sight and sound, and in some cases, touch. There have even been some experiments with addition of smell. It is completely immersing the user in the simulated 3D world. For this, the user wears special equipment like gloves, helmets, or goggles. Usually, it is the VR headset. The user will be able to fully interact with the environment. The equipment might even contain things like treadmills or stationary bicycles, to provide users the experience of moving. Fully immersive VR is still being developed but is becoming more common in gaming and educational purposes. (Heizenrade 2022; Sheldon 2022).

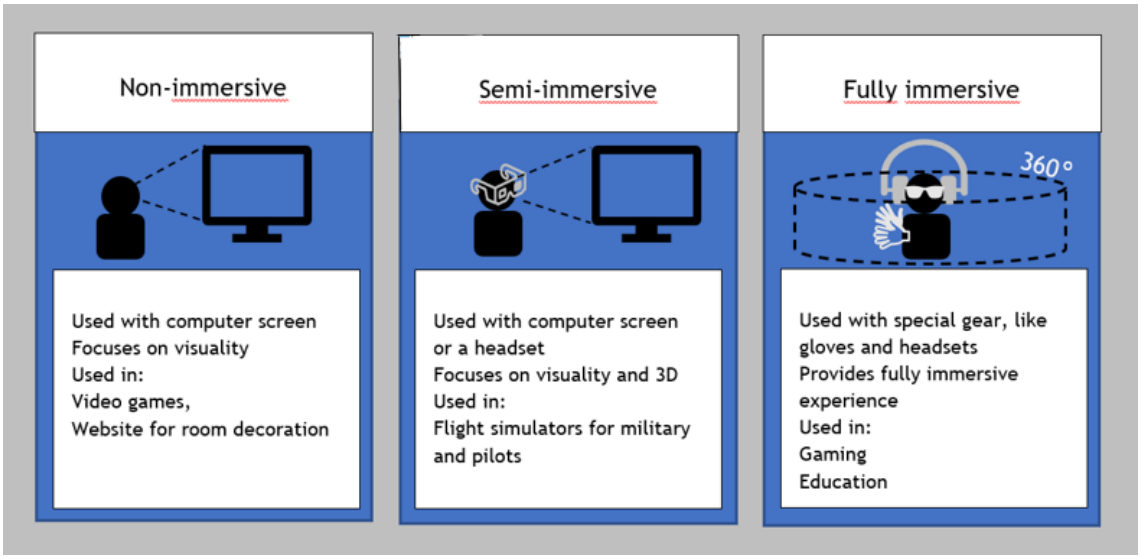

Figure 2: Difference between non-immersive, semi-immersive and fully immersive VR

Most virtual reality is accessed with the virtual reality headsets that display stereoscopic images by tracking head, body, and hand movements using high-speed computer processors and gyroscopes. (Varghese 2018).

Technology developed for smartphones is being used in modern virtual reality headsets, such as gyroscopes and motion sensors to track head, body, and hand movement, as well as small, lightweight, and fast computers to display stereoscopic content. As a result of these components, independent VR developers were able to build a VR headset that was relatively affordable, resulting in the Oculus Rift Kickstarter in 2012, which offered the first independently developed VR headset. (Kim 2016.)

It has become increasingly common for VR images and videos to be produced independently, thanks to the development of affordable omnidirectional cameras that can record 360-degree interactive photos and videos, though they are of relatively low resolution or highly compressed formats, so they can be viewed online. (Orellana 2016.)

Other fields sometimes considered to be virtual reality are augmented reality (AR) and mixed reality (MR), even though this is not entirely accurate, as the three technologies differ quite a lot of each other (Figure 3). Where virtual reality is something, the user can enter themselves, augmented reality overlays virtual simulations on top of the real world, and mixed reality blends the physical and virtual worlds together. (Sheldon 2022.)

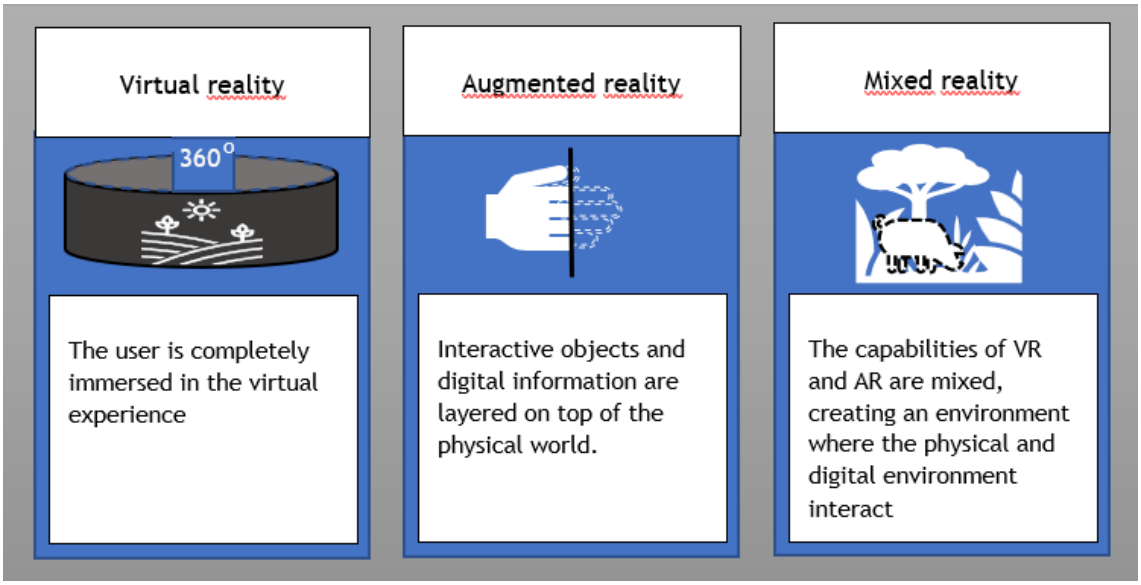

Figure 3: Difference between VR, AR and MR

4.1. Augmented reality

Augmented reality (AR) is the incorporation of virtual enchantments with real-world that utilizes objects in real time using graphic, audio and text. This is one of the reasons that shows how augmented reality differs from virtual reality. (Gillis 2022.)

With the use of augmented reality (AR) technology, a user's vision of the actual world is overlaid with a computer generated (CG) picture. In contrast to virtual reality, where everything the user sees is produced by a computer, augmented reality maintains the real-world emphasis while just adding items to improve the user's experience. Three elements make up augmented reality (AR): a fusion of the digital and physical worlds, real-time

interactions, and precise 3D identification of both fictional and actual items (INAP 2018.), such as Nintendo's Pokémon Go.

4.2. Mixed reality

Mixed reality (MR) combines the physical and digital worlds, enabling natural, intuitive 3D interactions between people, computers, and the environment. Computer vision, graphics processing, display technologies, input systems, and cloud computing have all made significant contributions to this new reality. (Microsoft Ignite 2022.)

Mixed reality includes environmental understanding such as spatial mapping and anchors, Human understanding for example hand-tracking, eye-tracking, and speech input, spatial sound, locations and positioning in both physical and virtual spaces and collaboration on 3D assets in mixed reality spaces. (Microsoft Ignite 2022.)

In order to create a mixed reality experience, you don't have to worry about physical constraints or obstacles, but you do need cloud computing and artificial intelligence. To process and store data in three dimensions, MR devices utilize advanced AI sensors, cameras, and graphics processing units (GPUs). More equipped devices offer a better mixed reality experience. Good examples are smart glasses, gloves, body suits, or even your good old smartphone. (Mattoo 2022.)

In order to access the software, MR devices should be connected to a computer, console, or PC via wired or wireless connections. Immersions can be created by adding, cloning, or moving virtual objects around you. A new generation of mixed reality headsets, such as HTC Vive or Meta Quest 2, provide high-fidelity environments that enable individuals to engage in virtual interactions, thereby dissolving the barrier between reality and technology. (Mattoo 2022.)

Furthermore, advanced input sensors and software development kits are crucial to creating an authentic MR experience. When input sensing fails, the immersion is lost. As a result of this complexity, MR technology creates an immersive experience that is undisrupted for users. (Mattoo 2022.)

4.3. Technological Models

Technological modelling is a process of design ideas being evaluated to determine if they are suitable for practical application (Technology 2022). Technology developed for smartphones is being used in modern virtual reality headsets, such as gyroscopes and motion sensors to track head, body, and hand movement, as well as small, lightweight, and fast computers to display stereoscopic content. As a result of these components, independent VR developers were able to build a VR headset that was relatively affordable, resulting in the Oculus Rift Kickstarter in 2012, which offered the first independently developed VR headset. (Kim 2016)

It has become increasingly common for VR images and videos to be produced independently, thanks to the development of affordable omnidirectional cameras that can record 360-degree interactive photos and videos, though they are of relatively low resolution or highly compressed formats, so they can be viewed online. (Orellana 2016.)

The technology and applications that make augmented reality work are divided into three categories. Location and mapping simultaneously (SLAM), depth tracking, and image projection are some of them. When put together, they make AR a reality. (Softwaretestinghelp 2022.)

With SLAM, digital images can be overlayed on top of real-world images. In order to take a full picture of a physical setting, sensors are used to capture localizing information. Using the AR device's camera for depth tracking, on the other hand, the device measures the distance between objects or surfaces. To complete the process, the AR application or the software calculates the dimensions and location accurately. (Softwaretestinghelp 2022.)

Augmented reality objects produced digitally are projected into reality when both applications are running simultaneously. To accomplish this, you'll need a device with a camera, such as a mobile phone or a pair of smart glasses. The computer vision technology used by AR software also allows it to recognize objects using image processing. As a result, the video stream is analysed or read by that technology. (Softwaretestinghelp 2022.)

In order to complete the process, the device receives cloud-based information regarding an object. The device adjusts to the user's size and orientation, providing a 3D experience that moves with them. (Softwaretestinghelp 2022.)

4.4. Description and delimitation of the development target

The VR glasses in a fully virtual event are already introduced in the introduction chapter, but this was only one concept the team created. Another concept the team thought of is

international VR-experience, for example customer would get the pleasure of seeing their favourite artist even if said artists never comes to Finland, they could also watch Formula 1 without traveling but still feel like they are in the audience.

Our other concept ideas include the possibility of seeing past events again for example seeing Queen perform at Wembley Stadium in 1985 or watch Finnish ice hockey team win gold in 1995 at Globen arena. Regular events at the arena, where customers could rent the VR-glasses to get upgraded event experience, for example hockey games where players names would appear above their head and the puck would be highlighted. Customer could also watch the event from the player's point of view, and music shows could even have moving and customer-controlled backgrounds.

One of the things that is needed, is co-operation with the event planners and - hosts so that the VR-glasses can be utilized in domestic and foreign events. The events would need cameras that could show at least 180-degree angles or even 360- degree angles if you so wish and sound system that would follow the persons head movement so that the experience would be as realistic as possible and seamless.

4.5. Laws and standards to protect the customer

The AR/VR devices are able to collect biometric information about the users, such as eye-tracking and facial recognition, along with the same information all other technologies can collect of the users (M&E Journal HITS 2018). So, there must be transparency, practical options, and security for the interested parties. For this, there are certain laws and standards.

Finland's Consumer Protection Act 920/2011 § entered in force 1.1.2012. Main point is that consumer goods and consumer services must be safe to use and must not to risk anyone's health or property. Responsibility is transferred to products manufacturer, importer, or service provider. (Finlex 2012.)

Consumer Protection Act 920/2011 says that the service provider must be sure that the consumer goods and/or consumer services must not pose a health or safety risk to anyone (Kuluttajaturvallisuuslaki 920/2011 §5). With the teams' concept in mind, Nokia should also make safety documentation identifying the risks that the different events might pose (Kuluttajaturvallisuuslaki 920/2011 §7). Considering VR glasses and their effects, Nokia should also inform customers about the risks associated with using VR glasses, for example dizziness or nausea (Kuluttajaturvallisuuslaki 920/2011 §9).

Standard is something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality (Merriam-Webster 2022). Standards are created to keep communality in products. They are mutually agreed requirements to products development and testing, that create safety around products and service. (SFS 2022.) In this thesis currently active standards are listed in Annex 1. Nokia should make sure their product is made using the active standards.

5. The sprint week

The challenge for the design sprint was to envision a future arena experience. There was five days to create an idea for Nokia that might be possible to be used in future Nokia Arena events. Five days is a very short time to develop a completely new business concept, so the week was hectic, and the team worked hard for the solution. With the design sprint tools the task was still manageable and the team found a solution that every party was satisfied with.

5.1. Methods and results

With a design sprint, there are multiple tools that can be used to gather information and knowledge on how people would feel about the idea, and to guide the sprint to the best outcome. During the short time reserved for the sprint, it would defeat the purpose to try to use them all so the team must first decide what types of research methods could give the best insight on the masses opinions and wishes. This was carefully considered within the team, and on the first day the team decided which tools they needed to use and when would be the best time to put them to use. Brainstorming tool was needed to find the best idea for developing, and to avoid any ideas getting ruled out before they were introduced to the team. The survey was necessary to map the feelings of the masses. The sparring was very beneficial for the team as it helped keeping the project on track and on time. And benchmarking was needed to map how original or not the teams' idea was.

5.1.1. Brainstorming

On the first day of the sprint, the team needed to set a vision and what to develop during the week. With a task of envisioning the future of event industry possibly as far as ten years from now, the team felt that brainstorming session would be a great way to get rid of "that is not possible" -type of thinking, and to achieve a solution everyone was satisfied with.

Brainstorming is a method that can be used during design sprint in the ideation phase. The tool helps every team member to have their voice heard, as there is supposed to be no judgement during the brainstorming session, and the point is to get as many ideas out as possible. It is important that the whole team has a clear idea of the target, there is a set time limit, and everyone is allowed to state their ideas. With this phase the team aims for quantity over quality, and no idea is too wacky or weird. (Interaction Design Foundation 2022.)

As everyone was throwing in their ideas, writing them down in a file without anyone further analysing them. After a 10-minute session the ideas were read out for the whole team and it quickly became clear that the ideas were quite similar, and the team was united in how they envisioned the future. This made the brainstorming session very short, as there was no need to vote for the best ideas, and the team was quickly set on one direction with their vision. The vision was to somehow include virtual reality into the event industry.

5.1.2. Survey

At the end of the first day the team had put together a vision and created a rough sketch on what the final idea might look like. At this point it was a good time to ask the masses how they would feel about the idea. There was a tight time schedule and the team needed as many answers and as quickly as possible, so after careful consideration, the team put together a survey, to map whether there would be demand for the idea the team had, and what direction should they develop the idea to.

A survey is a research method used to gather data from a group of respondents to gather data about chosen topics and interests. An online survey is usually a structured form of questions that the respondent can fill out over the internet. This allows the makers of the survey to gather information from many people quickly and efficiently. (QuestionPro 2022.)

The team made the survey with Google Forms and provided a link for their friends and families in whatsapp, as well as in an online bulletin board. The survey quickly gathered over 160 answers and by the day two of the sprint the team felt satisfied and ready to start analysing the results.

The first question regarding the team’s idea was if the masses would even be interested in taking part on virtual reality events, as it would be pointless to develop something that nobody wants anyway. In the survey, only 34,8% of the people answered that this would be an interesting opportunity (figure 4). After evaluating with the team and Nokia advocates, the team still concluded that this would be an idea worth refining, since this is an all-new

concept that was hard to describe in a survey type of questionnaire, and still over 34% said they would be interested. In the future, Nokia would have to do another survey with the prototype to see if the idea really is worth investing in.

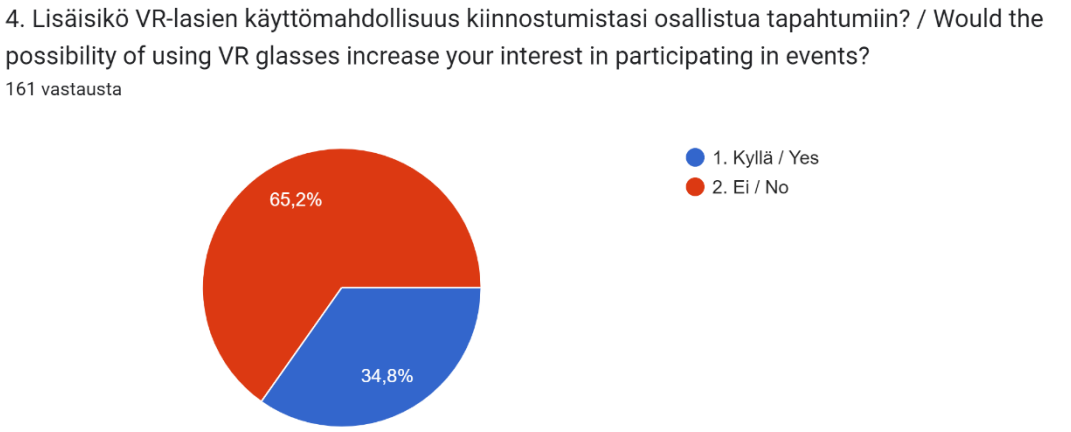

Figure 4: Possibility of a virtual reality

In the survey, the team also asked about the possibility of augmented reality (figure 5). With this, the results were even better, as 55.3% of the respondents said this would be an interesting concept.

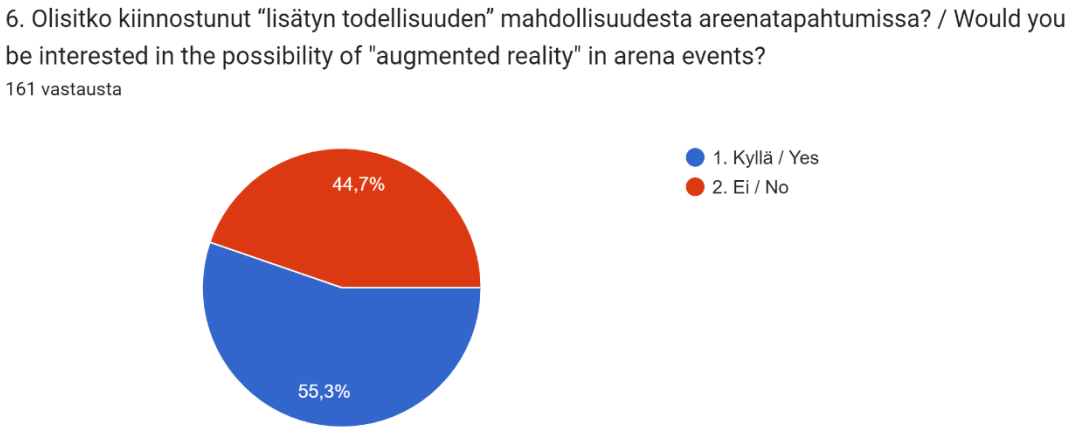

Figure 5: Possibility of augmented reality

At the end of the survey, the team asked for comments regarding their ideas. Most of the comments stated that participating in virtual reality events from home would be an interesting opportunity. This had not been thought as the objective was to create a future arena concept. The team however decided this possibility should be included in the solution.

With the information gained from the survey, the team could start developing the idea to the direction the answers and evaluation guided us. That would be making a concept containing virtual reality, but also possibilities for augmented reality and participating in the events from home.

5.1.3. Sparring and benchmarking

In work life, sparring refers to act of helping the other party to find new ideas and viewpoints for their project. The person doing the sparring listens to the project workers ideas and thoughts and mirrors them back with tips and guiding. (Xennek 2019.)

Benchmarking is an act of comparing two or more business models of a similar field, to find the best possible practise for the business. The purpose is to find the weaknesses of the business and to develop the operations accordingly. (Oppariapu 2022.)

Both of these techniques were put on use during the design sprint week. Sparring was implemented in the daily sparring sessions with Nokia advocates regarding what they had done so far and how the idea had moulded. During these sessions the team aimed to take every tip and idea seriously and develop the idea in collaboration with the Nokia people. The team found these sessions very helpful at refining the idea.

Benchmarking was implemented by online, as a team searched services about virtual reality and where it's in use. The teams benchmark results were that Even though virtual reality is widely used in different places, this type of event does not exist anywhere in the world yet, and therefore there are no competitors with similar concepts to compare ours to. This made the teams guidelines stronger, and they started to prepare to pitch the concept to the client company Nokia.

5.2. The final product

At the end of the week the team had the final product ready to be pitched for Nokia advocates. The idea was "VR of the future", a completely new type of event that could be held on the arena. This would be a fully virtual event, that the customers of the arena could

attend at the arena with VR glasses, or the customers could rent the glasses home from the same place they get their tickets and attend the event from home. This would make it possible for the arena to stream big events from other countries and bring the events to the customers, making these events more accessible. Even past events could be streamed, there is multiple legendary events in the history of event industry that people would surely be willing to pay for. For example, the arena could re-create an ABBA concert that would actually feel for the crowd like they are seeing ABBA perform live.

The VR technology at the arena would also make it possible to have events at the arena that normally would be impossible to be held at an arena environment. For example, formula races or moto GP, types of events that normally take place in a larger area than arenas, and the crowd could still feel like being there.

For the people renting VR glasses for home, the experience would be more authentic than regularly watching the event on a TV or computer screen. Even at home people could feel like they are on the site. This would make events more inclusive, as even people with many kinds of limitations could enjoy the show as if they were actually there. The virtual experience at home might also be more affordable than going in the actual event.

The idea also had third part, which would include augmented reality in the events. This would mean having a regular event, like a hockey, but with a slight surcharge, the customer could rent glasses, that would bring more to the event. For example, hockey games could have elements to make the game easier to follow, like highlighted puck and the players' names floating above the players. With this technology, concerts and plays could have more life-like props, the arena itself could transform its appearance and interior design, and the viewers could even choose the angle they want to watch the event form, like seeing a monster truck from the driver's point of view or watching the hockey game from the players point of view.

5.3. Pitching and aftermath

At the end of the week, it was time to pitch the idea for the Nokia advocates. A pitch is an opportunity to present your idea for someone who has the power to do something with it. It is a short speech encapsulating the idea into a tight and easily understandable package. (Berkun 2005.)

For the pitching the team had prepared a prototype of the product. In this case, as the team was talking about technics that do not completely exist yet, the prototype was just visualizations of how the product might look and work. In the end, the people of Nokia

seemed to have liked the idea, so the results of the design sprint were expectedly good.

6. Conclusions

The Design Sprint thesis process started with a kickoff meeting where the team was tasked to choose their task between: Next Generation Stadium, Network-as-Code for Nokia Arena and Network-as-Code Anywhere. The team chose Next Generation Stadium, targeting to adding the augmented reality (AR) and mixed reality (MR) to the Nokia Arena events, as well as giving the customers a chance to attend events from home with virtual reality (VR).

When sprint week started, the team met client company Nokia and got the guidelines how to proceed with their mission. First the team brainstormed ideas and tried to think the most innovating and consumer pleasing result. The teams' main purpose was to bring consumer closer to the client company. When the team found their idea, it was time to start working towards it.

Survey was created to see public/consumer's opinion about the innovative idea. Survey results came fast and so many that the team was more than pleased with the results. Survey gave the team the perfect guidelines to proceed. The team listened their audience's opinion and started to redefine the idea into a concept.

With the concept "VR-of the Future" the team can create an innovative and new experience to the consumer. The teams' concept to bring VR-glasses to the events can create an exclusive opportunity to see past happenings "live". For example, Wembley stadium Queen concert 1985 or miracle on ice hockey game to see like it's happening right that second. VR-glasses in arena happenings can also be used seminars to visualize presentation or educational purpose.

With the concept Nokia arena can increase number of customers and more business partners. "VR of the future" brings more marketing value to arena events at a larger scale. "VR of the future" could bring Nokia arenas future to this moment. Innovating new concept brings Nokia arena to the centre piece to the virtual reality market.

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Figures

Attachments

Annex 1: Standards

IEEE Standards Association is the leading organization in the arena of standards development.

Recent standards activities include:

IEEE Approves Standards Project Addressing 3D Body Processing

IEEE Announces Virtual Reality (VR) and Augmented Reality (AR) Standards Projects in Advance of Participation at Augmented World Expo

Pre-Standardization Efforts:

IEEE IC15-004-01 - 3D Body Processing

IEEE IC16-004-02 - Augmented Reality in the Oil/Gas/Electric Industry

IEEE IC16-005-02 - Consumer Healthcare Alliance

Active Projects:

P1589 - IEEE Draft Standard for an Augmented Reality Learning Experience Model

P2048.1 - Standard for Virtual Reality and Augmented Reality: Device Taxonomy and Definitions

P2048.2 - Standard for Virtual Reality and Augmented Reality: Immersive Video Taxono-my and Quality Metrics

P2048.3 - Standard for Virtual Reality and Augmented Reality: Immersive Video File and Stream Formats

P2048.4 - Standard for Virtual Reality and Augmented Reality: Person Identity

P2048.5 - Standard for Virtual Reality and Augmented Reality: Environment Safety

P2048.6 - Standard for Virtual Reality and Augmented Reality: Immersive User Interface

P2048.7 - Standard for Virtual Reality and Augmented Reality: Map for Virtual Objects in the Real World

P2048.8 - Standard for Virtual Reality and Augmented Reality: Interoperability between Virtual Objects and the Real World

P2048.9 - Standard for Virtual Reality and Augmented Reality: Immersive Audio Taxono-my and Quality Metrics

P2048.10 - Standard for Virtual Reality and Augmented Reality: Immersive Audio File and Stream Formats

P2048.11 - Standard for Virtual Reality and Augmented Reality: In-Vehicle Augmented Reality

P2048.12 - Standard for Virtual Reality and Augmented Reality: Content Ratings and Descriptors

P3141 - Standard for 3D Body Processing

(Digital reality 2022.)