EDUCATIONAL VR

AN EXPLORATION OF EDUCATIONAL VR FOR PROFESSIONAL USERS

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Abstract

This thesis explores Virtual Reality (VR) as a digital medium for teaching in a professional context. In collaboration with ABB, a pioneering technology leader, the thesis questions whether VR could be the future medium for training ABB service personnel.

The research discusses how you can design for VR, by drawing parallels to traditional mediums; Moreover, the research covers insights into the ABB education and VR explorations.

Three experience prototypes were designed as the final concept. These experience prototypes aim to highlight educational use cases through VR, covering collaborative work, safety guidelines and various utilities. The goal of the final experience prototypes is to engage potential users and designers in a dialog concerning VR as an educational medium of the future.
Fig. 1: Nasa Experimenting with VR in 1985
Introduction

Virtual Reality (VR) used to be exclusively a technology reserved for the military or scientific community (Oculus, 2012). Today, it is a product that shows promising applications, but still has not become a mainstream technology. Even though, VR head mounted displays (HMDs) like Oculus Rift and HTC Vive are at a marginal price compared to their predecessors, their sales are still not as high as many had hoped. Some speculate that the price barrier is still too high (Pressman, 2016), but you could also argue that the VR technology has simply not reached its full potential. Forbes defined 2016 as being the real kick start of VR in China (Hanson, 2016), which is why countries like China have seen massive investments and interest in VR already.

Naturally, with a new and upcoming market like VR headsets, it is still uncertain in which direction the industry will go. One would therefore expect to see a long range of different experimental VR applications, both in art, games and professional contexts.

My role, as an Interaction Designer, will be to explore how art, games and professionals use VR to convey experiences. I find it relevant to highlight the different strengths and weakness when interacting with a virtual world, to better understand how people react when you change their ‘(virtual) reality’.

This thesis intends to highlight some of the differences within digital mediums, to put VR in a perspective, where one can start to understand its capabilities as a future medium. These reflections of VR, will then be grounded in the ethnographic research of ABB and their current learning environment. With the new knowledge of VR and the ABB curriculum, it is relevant to explore several experience prototypes that combine the required learning requirements with the strengths of VR.

Each chapter ends with an overview, which act as a reading guide, that intends to draw a red line between the core concepts learned in each chapter.

Selected topics that appeared during the process are critically discussed, drawing parallels between the prototypes and the research conducted throughout the report. Finally, I will share a personal reflection on my VR design process and the effects of having a collaboration partner throughout the project.
Collaboration partner

My collaboration partner, ABB, provides services for industrial equipment, such as motors and generators all over the world. Customers of ABB can buy service contracts for their equipment, which requires ABB to maintain and keep the customer's equipment operational. By offering this service model, ABB needs experienced personnel who can work with the ABB equipment in various industrial settings. ABB is interested in knowing whether:

“Virtual reality (VR) can be used to train ABB service personnel to better perform repairs in the field?”

This thesis will focus on ABB Wind Turbine Drives (WTD), which are cabinets that connects to the wind turbine's generator to convert the energy before it reaches the power grid.

Abb has universities in 26 countries all over the world, but only a handful of these offers training with the WTD (ABB, n.d.). A drive setup for education costs a lot, why ABB must be strategic in which locations they invest. However, by introducing new and cheaper technologies like VR, they could see a significant cost reduction.

The education at ABB is separated into three categories: E-learning, On-site and Classroom Training (ABB, 2017).

E-learning focuses on a fundamental education, that teaches the participants the basics of working with an ABB WTD. The On-Site Training brings the classroom into the field, where they train at the client's own facilities. Classroom Training takes place at an ABB University that offers the ABB Drives training. This thesis will focus on the current E-Learning and Classroom Training.

Fig. 2: ABB Windturbine Drive Video
Chapter overview

The intention of my thesis will be to study the use of VR experiences on the current market, with the purpose to create a catalog of knowledge, that will help frame and understand the potential of VR technology. With this understanding, it will then be relevant to consult the relevant stakeholders for ABB and their training, to validate or disprove potential hypotheses through ethnographic research and user testing.

ABB’s initial question of whether virtual reality is relevant to them will be framed through my research, to ensure that the project scope will be within reason and has room for in-depth exploration.

My goal is not to have a close-ended solution, as I believe that this brief and thesis benefits the most from exploring more opportunities. My aim is to display multiple perspectives on how VR can train ABB service personnel.
Fig. 3: VR, literature and ABB Education
Method

The initial research will be conducted in three parts. First, there will be a practical exploration of the VR equipment and experiences, where I will consider the strengths and weakness of VR as a medium. As previously mentioned in the introduction, I also believe that the exploration should highlight the types of agency used in VR, and how gamified elements potentially could help the user navigate through the virtual world. Secondly, I will cover my research touching upon traditional digital mediums in comparison to VR as a medium.

The third section covers my early ethnographic research. During a research trip to Finland, I got the opportunity to observe and interview a group of six participants who took a course in the ABB WTD. However, for this section I will not only see the experience from their point-of-view, as I believe it is important to design a training simulation, with all the stakeholders in mind, to fully cover the different needs, agendas and perspectives.
**Digital mediums**

To understand digital mediums, one must learn to recognize and evaluate the established production standards (Zettl, 2008). This way, you can better your understanding of how digital aesthetic are changing in new mediums, such as VR. Herbert Zettl's book 'Sight Sound, Motion: Applied Media Aesthetics' describes two contexts for the digital medium: Associative- and Aesthetic contexts.

**Associative context**

Zettl (2008) refers to the associative context as being “How the world ought to work”, referring to how e.g. our association affects our perception within a given context. In fig. 4 the associative context makes the reader see both the letter B and number 13, depending on which context he reads the symbol in. This is the power of the associative context described by Zettl (2008).

When working with immersive mediums, I believe that the associative context becomes important. Because, as in Zettl's example, the correct associative context will ease the flow and make the reader seamlessly understand the intention of the content. However, if this associative context is broken, e.g. by following a different set of rules than you’d expect, then the illusion will be broken. My assumption is that experiences in VR that doesn't comply with your expectations of interactions, will break the immersive experience that the VR experience ought to be. This raises questions of how much agency the users should be given and how abstracting from the real world affects the users experience in a VR environment.

**Aesthetic context**

In contrast to the associative context that relies on prior knowledge and impressions, there is also the aesthetic context. Zettl (2008) describes the aesthetic context as the gut level and immediate responses to visual stimuli, using the example of optical illusions that uses simple stimuli to manipulate your perception of size (Fig. 4). This manipulation can occur, regardless of you being aware of yourself being manipulated. Another visual stimulus is desaturation:

“[..] by desaturating, even to the point of omitting chromatic colors altogether, we can entice the viewer to participate in the event, to look into rather than merely at it.” (Zettl, 2008)

This argument puts the purpose of an ABB Virtual Reality experience in perspective, as you then should question the purpose of ‘the event’ described. By adding full depth and focus on saturation, you could achieve realistic environments that will appeal to the user. However, on the other hand, you might lose the focus and concentration of the user by adding too much distractions and details in areas that are not relevant to ‘the event’.
Fig. 4: Associative context and Aesthetic context (Zettl, 2008)
Framing of digital content

Working with a digital medium, you are often in control of how the content should be framed. Filmmakers use the frame as a tool to guide the story, making the viewer aware of details within the scene that will help them understand the plot of the movie (Brillhart, 2016). However, that is only possible since the content is confined and framed within limited space e.g. a cinema canvas or a theatre. Jessica Brilliant (2016) at her Google IO presentation, distinguishes the framing of digital content in two ways: the traditional frame and the VR frame.

The traditional frame

In the traditional frame, you fixate the viewer’s eye to a defined frame. Within this frame, you can have a focal point e.g. the person traversing the glacier and his backpack. Jessica Brilliant uses this example (fig. 5), as an argument for how the traditional frame allows you to curate a certain story, which allows the viewer to lean back and absorb the story presented.

The VR frame

The VR frame does not exist within the same boundaries as the traditional frame, as the viewer now gets full control of where to look and can often move around within the virtual world. This means, that the canvas is not a flat medium, but rather a fully immersive 360-degree canvas. The focal point is still there, but at the same time there is a completely different story happening on the other side of the spherical canvas. That means, that the directors of these experiences, therefore should curate a story that is relevant regardless of where the viewer is in any given time of the story.

This also becomes relevant when designing the ‘good VR experience’. During the research of VR as a medium, I also set out to try various games and experiences, which resulted in various realizations of what I personally preferred in VR. Often, it was connected to this type of VR storytelling, where the whole space was utilized.
One example is the ‘We Wait VR’ experience, which is a story based VR experience. Here, you participate as a main actor in the documentary styled animation movie. You can look around and experience what refugees have experienced, almost like you were there yourself. Meaning, that if you decide to focus on the people in the boat you can; But the story does not break by focusing on the environment and the dark deep sea that you are currently sailing on. Despite the viewer being able look around as they please, the story remains curated and develops according to a timeline.

Another example is the game ‘I Expect You to Die’, which puts you in the role of being a secret agent who must solve complex puzzles by using any means possible. The purpose of the game is to search various rooms for clues that can assist you in solving the puzzles. In contrast to the ‘We Wait VR’, we here see a more individual experience, where you can explore and interact with the virtual world as you please. There is no clear sequence per se. It is up to the individual to figure out how to proceed, as the world is designed with multiple outcomes in mind.
Locomotion

Locomotion is an act or the power of moving from place to place (Merriam-Webster, 2017). In VR, there are currently multiple ways of navigating, but there are already some standards that seem to appear. A list of the most common locomotion methods was compiled by exploring various VR experiences. The categorization and understanding of the individual locomotion method helps distinguishing strengths and weaknesses, to better the understanding of how VR environments should be designed.

In researching the current locomotion, there were two primary types of locomotion: Active locomotion and Passive locomotion.

Passive locomotion

In passive locomotion, the user does not move around the virtual environment, but rather sits and observes as the story goes by. This type of interaction was often seen in storytelling experiences, where you were following a clear narrative as previously explained in the ‘We wait VR’ experience. The clear benefit is, that the story can be strictly curated, to ensure that the user is presented with the information needed to follow the story. But on the other hand, it lacks control and therefore does not encourage the user to actively participate in the experience.

Active locomotion

In contrast to the passive locomotion, users in active locomotion navigate the virtual environment using various remotes and controllers. By doing so, the user gets to actively participate in the VR story, by interacting with the environment and making their own choices. Active locomotion can result in ‘Cyber sickness’, as the user has a compelling sense of self motion through moving visual images (LaViola, 2000).

The symptoms are similar to what you would feel while experiencing motion sickness, but ‘Cyber sickness’ does not require the user to physically move. This means, as a designer, you will have to be aware of your choice of locomotion to minimize the risk of nauseating your users. The results may vary depending on the user and whether they are prone to becoming motion sick.

Following are four examples of common active locomotion methods.

Fig. 9: Passive locomotion
Fig. 10: Controller
Using a gamepad, the user can move freely around the virtual environment like traditional console games.

Fig. 11: Playarea
Play-area uses room sensors to track the physical space, allowing the users to move within the virtual environment.

Fig. 12: 1st-person teleportation
First-person teleport is a point and click interaction in VR, where you with a laser pointer can teleport to areas around the virtual environment.

Fig. 13: 3rd-person teleportation
With a holistic overview of the virtual environment, the user can select an area to teleport to.
Early prototypes

By testing the various VR locomotion methods, various assumptions occurred, but remained invalidated. As stated, the motion sickness can differ a lot from individual users, so it was relevant to test selected locomotion methods. The selection was based on personal experiences with VR, where Play Area and Teleportation felt the most natural. However, at this point it was also interesting to investigate how the perspective of the given VR environment could influence the users. The test was separated into two sections:

• Teleportation in first person.
• Play Area from a top-down perspective

One participant even described this experience as nauseating, as there was no physical connection when colliding with the virtual wall. Moreover, it seemed that these odd collisions were caused primarily because of the lack of reference (Fig. 16), as one participant reflected how he was hindered from jumping to a specific point as obstacles blocked his view.

Unity VR prototyping

The prototypes were also a platform to test various VR toolkits (Appendix 1) for Unity.

These VR toolkits provided a quick start to VR, where you easily could implement simple locomotion methods and interactions. However, to get more flexibility in the design process, I decided to stick to the most minimal toolkit: Newton. Newton, as the name suggest, focuses primarily on basic interactions and physics.
Fig. 16:  
User looking for a reference point

Fig. 17:  
User zooming in on the content.
This section will highlight the core learnings from two of ABB's WTD Educations: E-Learning and Classroom Training in Helsinki. To understand the relation of the two, I found it beneficial to analyze them individually. The outcome of their analysis will act as an argument for a further project scope within the ABB Education.

E-learning

The E-learning system at ABB resembles an online education format, that many e-course students may recognize. It is a standardized system, consisting of a list of exercises, which individually indicate their state of completion. It is a non-linear experience, meaning you can do the exercises in whatever order you would like. Upon opening an exercise, you are met by a pop-up window consisting of the exercise content. It includes both teaching and quizzing. Upon completing the quiz, the system will determine your score and let you know if you passed.

The topics of their e-learning system covers topics ranging from the installation of the drive to the biannual maintenance. I categorized the e-learning into the following groups:

During the introduction, the student learns the basic information about the WTD, such as safety and its capabilities. The e-learning then moves on to describe the procedure of how to install the WTD. From here, it slowly merges into the third section, which focuses on checking the WTD after it has been installed. This is also known as commissioning, where the Service Engineer learns how to run test on all the WTD functionalities. The forth section is service, where the student learns how to repair and maintain the WTD.

Classroom Training

The research of the classroom training was conducted over two days, where I participated in a WTD Course at the ABB University in Helsinki. Their client for this specific training was Vattenfall, one of Europe’s leading energy companies, who manages several wind turbine parks (Vattenfall, 2017). Six students were selected, to go learn more about the ABB WTD that Vattenfall uses in their wind turbines.

Day one of the course focused mainly on getting familiar with the drive. The students had not had any prior lectures, nor had they participated in the e-learning courses, which meant that the training had less time for exercises. On day one, concerns about the content started to rise, as the students came with a clear purpose: To learn how to maintain the ABB WTD.
Day two was focused more on practical examples, yet, the focus of the lecture was still broad and focused less on the maintenance of the WTD. As with the e-learning, I mapped out the overall topics covered by the Classroom Training: Apart from the general introduction, the classroom training also focused on the individual modules within the drive. A clear benefit of this training compared to the e-learning, was that they had a physical drive to observe and disassemble. That meant, that the modules training could focus on hands-on exercises where the student would be asked to find a specific component within the cabinet.

**TRAINING CENTER**

| MODULES | UPGRADES | LOGGING | RND |

Fig. 19: Classroom exercise structure

*Upgrades* were also discussed as part of the education, to teach about components that could ease the students day-to-day work.

*Logging* consisted of exercises that used WinDrive, a software that reads data directly from the drive, allowing the service engineers to access error codes.

The forth category I named *RND*, as this consisted of uncategorized subjects e.g. the warranty of the drive or questions answered by the teacher.

**Interviews**

No cameras or recording equipment was allowed within the ABB facilities, but several unstructured interviews (Rogers, Sharp & Preece, 2011) occurred during the breaks. This lead to a quick sketch of their work environment, which helped to understand how different their work environments can be. In fig. 20 you see a sketch of Vattenfalls role in a Danish wind farm. They act as the maintenance people, who in teams of two repairs Siemens wind turbines. In this type of wind turbine, the ABB WTD would be placed in the foot of the turbine, whereas a Vestas wind turbine would have it in the nacelle.

The environment changes, as some are situated off-shore, but others are on-shore. However, it is the same team of people who would maintain these. Safety was very important, but the students admittedly said that the more experienced they became, the less they worried about safety guidelines.
Project focus

E-learning was a useful tool for teaching remotely, where the student could get a good fundamental understanding of how the drive works while being tested in its content. At the same time, it felt like a rather static process, where content often felt far from the real world.

In the classroom training, there was great potential in using the teacher to engage and solve problems with the students. However, the classroom training had limited space and not all students could be involved in the practical exercises. It also became clear, that the VR education should not try to replace the practical exercises completely, as the students were hands-on people who learned by doing. Also the current state of VR, where physics and tangibility does not match the real world, replacing the practical training did not seem feasible.

From an interaction perspective, it was interesting to explore social and practical exercises, to explore how VR could help engage the students. That lead to a decision of merging parts of the two educations into a new focus, that I envisioned to be positioned in between e-learning and classroom training:

Service and Module were intertwined, as Service explained the process of maintenance and fault tracing, whereas the Modules exercises trained the students in finding and taking apart modules within the WTD. From a VR perspective they were interesting topics, as they focused on navigating the drive, while learning the basics of how to maintain the drive. There was potential for an interesting mixture of informative exercises from the e-learning mixed with hands-on exercises from the classroom training.

With a more defined project scope, questions regarding VR started to arise. As the classroom and work environment of these students were all focusing on collaboration, it questioned how that could occur in VR. Knowing that VR with the current HMDs isolate the user from its surrounding, it filters out some of the possibilities of interacting with people outside of the experience. It was therefore relevant to question:

**HOW ARE YOU A TEACHER IN VR?**

**HOW DO YOU COLLABORATE IN VR?**

Instead of focusing on what VR cannot achieve, it became interesting to wonder, what can you do in VR which would NOT be possible in the real world. Leading to the last and final design question:

**WHAT ARE YOUR VR SUPER POWERS?**
Chapter overview

Prototyping for a medium like VR, taught that the design process had to be different. As mentioned, the medium does share properties with a traditional medium, but design and curating experiences requires a different toolset.

The research hinted that unexpected behaviors in VR can confuse and nauseate the user, hence the interaction you design for has to be chosen carefully to prevent ‘cyber sickness’. This also means, that prototyping and user testing becomes much more important during the design process.

The result of the research, the questions and focus within the ABB education, helped in approaching the design opportunities for educational VR. With a clearer goal and focus, it was easier to disregard areas that was no longer relevant to the given area.
Design Process

Mapping out the ABB Education, as well as studying various VR Experiences helped in shaping the design process. By building up a repertoire of questions and having assumptions of what would work in an ABB VR Experience, it was possible to structure workshops and ideation sessions.

The design process was kick started through two workshops, while simultaneously testing Unity and the Oculus Rift. Using the research as a foundation for the workshops, it was possible to setup a frame to ideate within, which brought multiple views and perspectives to the design process. It is important to note, that research which at this point is not mentioned, was never left behind. The research was used as a range of tools and lenses, that could be applied on a given problem to add new perspectives. One of such perspectives was the superhero question, as it became a general inspiration, that added perspectives beyond the literal translation of educational content into VR.

From early ideations and tests, the design process moves on to define three general concept directions. These directions are shortly described during the design process, but will be described in depth later, when outlining the final concept.
Early ideation

After an individual research phase, more people were included into the design process, to add multiple perspectives and solutions on given problems and questions. Initially, one workshop was planned, but the results did not suffice and a second workshop was hosted.

Workshop:1

Workshop one was facilitated at Umeå’s Institute of Design. Two students were invited to share their ideas and thoughts on the project. The workshop was structured according to the project focus and questions stated in the research.

Each question got its individual sketching round, consisting of five minutes, where the individual designer got to sketch out one or more ideas. As all three rounds ended, the designers were then asked to share their thoughts on their own ideas, as well as reflect on what other people had sketched.

In fig. 23 you see some of the sketches from the workshop, where it is rather clear that they all focus on a clear context. The ideas were good, but was very close to a literal translation of current ABB content, that was found in either the e-learning or classroom training. At this point, the ideation felt limited because of the wind turbine context. The expected outcome of hosting a workshop was to get a broader perspective on VR as a tool for education, rather than focusing on the WTD.

Workshop:2

The realization from workshop one, lead to its second iteration. For the second workshop, the same questions were used, but the wind turbine context was kept out of the picture; Moreover,
new participants were brought in, to prevent too much of a bias from the previous ideation session. As a result, the ideas seen in fig. 24 are covering VR concepts that covers collaboration, teachers and superpowers, without being limited of the wind turbine context. These ideas, like the research, were tools and lenses that would add richness to the further development.

Testing the technology

Simultaneously with the ideation, I furthermore explored possible design solution, by setting up a 360-photo experience with a simple UI in VR (Appendix 4). The purpose in this exploration, was to see how viable it would be to document the real context and use that as a scene for learning. However, it quickly became apparent that in confined spaces, you experienced distortions on the image, which ruined the immersive experience as you felt the constraints of the spherical photo.

A second experiment focused on haptics. Oculus offers control over the haptic feedback delivered by their controllers (Oculus Developers, n.d.). This control, allows the designer to feed a sound file to the controller, that then will be converted to vibration patterns. This functionality proved to be very interesting, as once you connected the file with a given action, you simulate having e.g. a power drill in your hands (Appendix 4).
Initial directions

A culmination of research, ideation and prototypes led to determine the initial concept directions. The question of superpowers, became a source of inspiration in the design process, rather than a concept direction. The question of VR Collaboration and Teacher remained as the core of the new concept directions. A third question of how you have an individual learning was added, as it felt natural to have three directions that each focused on different social experiences within VR.

Additionally, the project focus from the research was brought back, to connect the concept directions into real-life applications.

Teacher | Emergency Situations

In the teacher concept, the focus is to capture the student <-> teacher interactions observed during the classroom training. It will allow the teacher to observe and test the student’s behavior by managing emergency situations in VR.

Collaboration | Maintenance

Two students are in focus in the collaboration concept. As a team, they have to solve tasks related to maintaining the WTD.

Individual | Safety Guidelines

The individual experience uses the current safety guideline outlined in the manual as a format for self-learning in VR.

Prototyping VR

Several mediums and approaches were used to prototype the three concept directions. The teacher concept was prototyped in VR, but this proved to be too time consuming (Fig.25). That meant, that new ways of prototyping VR ideas were needed, to quickly produce content to test. Video was used to prototype the individual concept, where simple overlaid graphics and sounds illustrated gamified elements in the experience (Fig. 26).

The collaborative concept was communicated through a small exercise prototyped in LEGO, which was documented by recording three user tests (Appendix 2). Later, this concept was iterated by doing story boards traced on top of a VR environment (Fig. 27). Using the VR environment to sketch on, helped understanding the three-dimensional space, that allowed to draw on the learnings from the VR research mentioned earlier. That meant, that it was possible to ideate on where things should be placed according to the user, to fully utilize the 360-degree environment.
Fig. 25: Emergency Situation VR Prototype

Fig. 26: Collaborative Experience Storyboard

Fig. 27: Safety Guidelines Video Prototype
**Concept Evaluation**

With low fidelity prototypes of the three concept directions, it was possible to move forward with the first idea evaluation with ABB’s Service Engineers. The evaluation took place at ABB’s Business Center in Umeå, where the VR prototypes were presented to a service engineer and a business representative.

A general feedback, was that it would be great if the VR experience would not just capture a single WTD model, but if it somehow could emphasize the vast amount of different drives that the service engineers should be familiar with. Currently, the service engineer is required to know differences within the drive, based on year, model, size and optional add-ons. The engineer described this work to rely mainly on experience, where you simply over time will have “seen it all”, and therefore effectively can fault trace a WTD in any given context.

The need of collaborative skills was confirmed, where they highlighted how sparing with your partner before any maintenance was an important factor in their fault tracing. Also the safety guidelines was approved, as something that you simply have to be aware of before working to prevent any harm to the machine and themselves.

For the teacher concept that focused on emergency situations, the feedback was focused mainly on how teaching emergency situations was important, but at this point could be redundant due to Swedish regulations that requires emergency training every two year. Meaning, that they were already required to have excessive evacuation and medical training biannually and therefore were less interested in that as a VR experience.

This feedback, resulted in a shift of focus for the final concept (Fig. 28). The emergency situations were removed, but the teacher was moved into being a secondary experience. The idea was, that rather than removing the work that had been done, it would be relevant to showcase small demos showcasing a teacher’s presence in VR, but without having a fully fleshed VR experience. That also includes previous prototypes, that e.g. focused on haptics, which would be categorized as a utility. The remaining two concept directions remained as is, which then became the primary experiences within the final concept.

![Fig. 28: Final Concept Focus](image-url)
Chapter overview

The early ideations assisted in broadening the perspective of what VR for ABB could be. Rather than taking lead on one or two ideas directly from the ideation, the process still tried to remain open for new directions.

Only through prototyping and evaluating the initial direction, was it possible to narrow down the concept to its final directions.

The following chapter will go through the process of designing the final VR experiences.
Fig. 29: Final Concept Exhibition
Final concept

After the evaluation narrowed the final concept down to two primary experiences, the process shifted into making the final experience prototypes. As mentioned, the process would focus on two primary experiences: collaboration and individual, whereas the secondary experiences are VR snippets that shows different micro interactions in VR.

The final concepts were intended to be demoable VR experience (Fig 29), so the individual stakeholders could get an idea of what a potential ABB VR Experience could feel like. These prototypes were showcased during the UID17 Degree Show and at an internal presentation at ABB in Västerås.

This chapter will go through the three experiences, and explain the reasoning behind the design. It is important to note, as the introduction states, that these experiences are aiming to start a discussion around what educational VR potentially could be for ABB; Meaning, that these designs are trying to communicate experiences rather than solutions.
Collaboration: Maintenance

As both the work environment and ABB classroom training consisted of collaborative work, it was natural that part of the final concept should focus on this social interaction. In designing the experience, it was interesting to apply the dynamic seen in the classroom, where one student would formulate the assignment and the other would execute the tasks. This way, it seemed that both learned from one and another, meanwhile they had a focused task that they individually could master; Moreover, the LEGO example (Appendix 2) also highlighted how time and the separation of their task, could increase the need for clear communication and team work.

The collaboration therefore was designed with two roles in mind: the **mechanic** and the **support**. As the mechanic, your task is to communicate the VR environment, by describing the WTD. It is then up to the support to use the information to navigate the Firmware Manual to find the problem and propose a possible solution. They are not allowed to share the screen or manual with each other, so all information has to be shared verbally.

Fig. 30: Collaboration Concept
The mechanic

Designing the task for the mechanic, was all about making an environment that was familiar to the real world WTD, but enough to navigate and work in VR. In fig. 32 you see a sample of the experience, where it is noticeable how the level of details has been kept to a bare minimum. This was an intentional design decision, to focus more on ‘the event’, as the desaturation theory described by Zettl (2008).

The drive itself, resembles the look of an ASC880 Drive (ABB, n.d.). Each compartment is designed according to the original drive, but for the sake of demonstration only selected components were designed and added in each section of the drive. Primarily the content focuses on the main circuit and power modules.

The support

The main component that had to be designed for the support was a manual (Appendix 3), that would fit in line with the current Firmware manuals. To do so, I studied the ASC800 Firmware Manual, specifically the sections of fault tracing and error codes.

The difference of the manual designed for this VR experience, was that it had to include information about the exercise and roles of the participants. That meant, that it was needed to outline which steps that the students had to go through to complete the task.

The steps of the collaborative task are:

1. Determine drive MODEL
2. Find the ERROR CODE
3. SOLVE the problem
4. TURN ON the drive

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**Individual: Safety Guidelines**

A primary consideration for designing the individual experience was identifying which part of the training was the most individual learning. The conclusion was, that important information such as the safety guidelines, seemed to be too important to learn in a group setting. Simply, to allow the individual student to study the safety guidelines in the pace that they would need. The individual concept was designed as a memory game, to force the students to remember what they have read in the safety guidelines.

This experience is divided into three phases:

1. Memorize
2. Execute
3. Evaluation

The first step is to **memorize** the safety guidelines, where the student will have to know which dangers to pay attention. When the student has studied the safety guideline, they enter the VR experience to **execute** their task. Here the student sees a small WTD, with only three compartments (Fig. 34). The student must complete all the safety procedures that were mentioned during part one. Within the VR experience, the student is granted a VR Super Power, that provides an X-Ray view into the WTD (Fig. 35). Here the danger zones from the safety guideline are marked, to help the student understand where the dangers are positioned within the drive. When the student has safely prepared the, they finish the experience and receive their **evaluation**.
Fig. 34: A smaller WTD

Fig. 35: Using X-Ray to see within the WTD
Utilities

Multiple scripts and interactions were developed during the VR explorations done in Unity. Rather than leaving those behind, the utility experience tries to collect some of them to display micro interactions for ABB. Because, as these experience prototypes were not focusing on a final solution, but rather work as discussion pieces, it was important to also highlight micro interactions such as haptic feedback which had not been implemented in the primary experiences.

The utility experience is a sandbox experience, where the user will start in the middle of an open plane. From here, the user has access to multiple tools and intractable objects. It is a sandbox experience, as there is no way to finish the experience. The examples in this experience are:

- Teacher’s Point-Of-View
- Haptic feedback through a power drill.
- Power module assembly
- Display of various object mass

The haptic feedback is displayed through a power drill example, where the sound of a power drill triggers the vibration motors of the Oculus Touch. In the x-ray vision example, the user will get to toggle an x-ray super power, to be able to look through a WTD. The power module assembly was an idea, which originated from the collaborative concept, but caused problems with the overall task. It is an example of how modules can exist within modules, where the user potentially should be able to disassemble and reassemble a real power module.

The object masses example takes part of the final discussion around how object feel and appear in VR.
Process overview

Through the involvement of current VR experiences and ABBs users, it was possible to create several experiences that individually highlight different curriculums relevant to their WTD classes.

VR as an educational medium was used as a phrase to engage stakeholders in a conversation of the future of VR as an educational medium. Future work on this subject, should however take education into account from an academic perspective. Many of the decisions throughout the process are based on personal reflections and observations of various participants engaging the with the experience prototypes, rather than focusing on current literature on education.

Following is a discussions and reflection on selected topics that appeared during the thesis.
Discussion

As the research guided and framed the project, it is relevant to discuss whether the research and decisions remains relevant. The discussion is separated into two primary parts, one focusing on the ‘Fidelity in VR’, whereas the last discussion will reflect on future work that could be relevant to this thesis topic.

For discussing the Fidelity in VR, it is relevant to bring back the theories on digital mediums by Zettl (2008). Using the associative and aesthetic context, this chapter will try to highlight pros and cons within the micro interactions in VR.

Part of discussing the future work, is also to reflect on topics that had surfaced throughout the research and design process, which still has potential for more exploration. The key topic here, is the notion of “VR Superpowers”, which was a question that surfaced during the VR explorations.
**Fidelity in VR**

Early discussions in the design process related back to the initial theory of desaturation from Zettl (2008). His notion of how desaturating colors within the medium entices the viewer to participate in the event, rather than looking merely at it, was something that seemed reasonable for an educational setting. It was important to be aware, that since this thesis focused on a professional and educational setting, it was less about impressive visuals than actual learning experiences in VR.

![Fig. 40: Early drive](image)

**Final VR fidelity**

With the research of desaturation (Zettl, 2008), it was relevant to explore how you could apply this approach to an ABB educational VR environment. The first implementation was the WTD, as this was a key component in the education. In Fig. 40 you see one of the earliest versions of the WTD, where there is a clear resemblance with the real world version (ABB, n.d.).

![Fig. 41: Module stickers](image)

However, within the opened doors, it is apparent that the content is missing. Modules were added within the drive, as soon as they became relevant to the demo. Meaning, that rather than adding all of the components, I found it beneficial to focus on the exercise to not get caught in detailing components that may simply confuse the task at hand. In fig. 41 you see a set of power modules being added, but still simplified compared to the real world WTD. Small stickers with the right color scheme were implemented, which helped correlating the VR modules to the real world modules. This level of detail felt sufficient enough to communicate which module the otherwise grey square box was resembling.
Point of Interaction

Simple interactions, had a bigger impact on the user's than expected. One user described objects going through their virtual body without any feedback to their physical self as an unpleasant and almost sickening experience (Appendix 5). Here, among other examples, it seemed to relate to the associative context described by Zettl (2008). The expectations of how ‘the world ought to be’, arguing for how we simply by looking at an object will pre-determine what it is ought to be. When this expectation is not met, it seems to cause issues such as the user described above.

An other problem was discovered during the implementation of physics into the experience. In appendix X you see a user throwing boxes, all at the same velocity. In the virtual reality, you however see that there is a big difference in the game physics and size of the objects. Big objects are expected to be heavier than smaller objects, which can be simulated through the mass of the object. However, as noted, the illusion is broken when you do the throw with the controller, as you simply cannot feel any difference between the boxes.

Hands vs. Controller vs. Invisible

Building upon the problems regarding the controller interaction, it was also apparent that there were issues lying within how you grab objects in VR. Earlier prototypes (Fig. 42) explored the use of real hand avatars, that gives you some controls over the gestures of the hands. In Fig. 42 you see where the problem occurs, as the user grabs a cube. By default, you are able to grab objects from odd angles, which causes a mismatch between the expectations of real hands grabbing and object and what happens in VR. To prevent this poor correlation, it was then relevant to explore the use of controllers as a tool for interacting. Upon using the controllers (Fig. 43), it was apparent, that this type of interaction felt more forgiving. With little to no expectations of how a VR controller should grab an object, the issues lies more within how the objects would pivot according to the controller. A third implementation was tested, which removed the controllers upon grabbing an object (Fig. 44). Making the controller invisible made the object become your hand, which felt more natural, why this was the implementation used in the final experience prototypes.
Future work

This thesis project's scope was intended to remain focused enough to keep it relevant to ABB, while open enough to explore VR as a medium. It is therefore relevant to discuss, how the previous question of VR superpowers had a role in the design process and how the general learnings are going to be delivered to ABB.

Super powers

From the VR explorations that were conducted during the research, a question for the design process was: “What are your VR super power?”. With this question, the design was reminded that it had to go beyond what was merely a literal translation of the real world into VR. In the individual experience focusing on the safety guidelines, you see the most apparent super power, which allows the user to see the dangers within the cabinet (Fig. 35). An other example, is the invulnerability, which means the user will not feel any harm when they do something wrong. This is a clear benefit, of moving into a VR environment, as you can allow the users to explore without hazardous consequences.

However, the statement of having this topic within future work, is simply because I believe the topic of ‘VR Superpowers’ has great potential to be explored further. Essentially, finding the traits that can make a VR experience unique, could be the solution for how you should “Design for VR”.

Knowledge catalog

Throughout the explorations done in this project, it was apparent that the knowledge catalog was based on own reflections and experiences working with VR. Those thoughts were captured primarily through the live exhibition at UID and during the presentation at ABB. The work emphasizes an early exploration of VR for professional use cases, hence there are still uncovered areas within the potential of educational VR. With the feedback from the live demos, it was clear that VR has relevance to the industry, as different stakeholders could relate with their personal experience and ideas within their given field. I would therefore encourage future explorations of the potential within educational VR.
Reflection

To reflect on the process and thesis as a whole, I find it relevant to see it through two different lenses. The first one being, the design process of working with VR as an Interaction Design student. Secondly, I intend to discuss the relevance of the thesis from a corporate standpoint as well as reflecting on my experience working with a collaboration partner.

I had a lot of scepticism towards VR, as VR as a field felt unapproachable for non-developers. The question was whether I as an interaction designer would be able to join in on the discussion, and provide value insights into the world of VR. I believe, that my scepticism was a good critical starting point, but admittedly throughout the process it appeared that the need for interaction designer was more apparent that initially thought. Working with VR taught me that as an interaction design student, you should get more involved with new technologies, to break down the illusion of the new technologies being only for those technically capable. The reason being, that many of the problems (such as the micro interactions from the discussion), were topics that felt mundane yet felt very unpolished within the current VR environments. Meaning, that as an interaction designer, we have to involve ourself in new technologies to create a solid user experience foundation, before the standards of VR become too established.

This thesis serves as an early exploration of VR from a design perspective, that gives an honest insight into the design process of three experience prototypes targeted the corporate industry. It also draws on traditional prototyping and sketching, showcasing how we as designers can use already familiar tools (e.g. Video sketching) to prototype new mediums like VR. By sharing the process, I believe that others can benefit and assess some of the learnings with VR that I had throughout the design process.

From a corporate standpoint, VR seems to be an emerging technology that is hard to position. Not many companies, have figured out what, when and where to use VR. ABB were aware of VR, but figuring out a potential in a new market can be expensive and time consuming without the right resources. As a student, you have the freedom to work independently from a corporate agenda, while maintaining a relevance towards their needs. This was especially useful in the process of framing my VR research, as I was able to draw parallels between literature and experiences from the current ABB curriculum. In other words, working with a collaboration partner, broadened my VR discussion, rather than limiting my view to only an academic standpoint. This I believe, also benefitted ABB, as they got a view on a business opportunity that they might not have come up with internally.

Good interaction patterns and experience could arguably be considered universal, which is why it is important to note that corporate work is not as far from academic research as one might think.
Reference list


Appendices

1: VR Tool Kits
2: Collaboration Exercise
3: Manual designed for VR Exercise
4: Testing VR Technology
5: Early User Tests
1: VR Tool Kits

VRTK

Virtual Reality Tool Kit (VRTK) helps with developing VR experiences in Unity. They provide scripts and implementations of the most basic locomotion methods seen in VR.

Newton VR

Unlike VRTK, newton offers very little VR scripts. It is rather focusing on VR physics, so that you easily can grab and interact with objects. It offers a great sound engine as well as good examples for making doors etc. in VR.

Unity VR samples

Unity provides a simple tutorial and examples of how to get started with the most common VR HMDs.
2: Collaboration exercise

https://vimeo.com/225982547
3: Manual designed for exercise

https://drive.google.com/file/d/0B6XIwum4hS30RjYzTi1fdm1mZnc
4: Testing VR technology

https://vimeo.com/228053110
5: Early User Tests

https://vimeo.com/228047579