

ELEVATOR INSTALLATION IN VIRTUAL REALITY –

**HOW PRACTICING IN VIRTUAL REALITY AFFECTS LEARNING EXPERIENCE & COULD
IT ENHANCE TRANSFER OF TRAINING**

CASE STUDY AT KONE OYJ

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Purpose of this study was to find out how practicing in virtual reality affects learning experience and could it enhance the transfer of training. Study was carried out in industrial setting in collaboration with KONE corporation. Effects of the simulation training were evaluated with a survey and theme interviews. Based on this case study it is safe to assume that practicing in virtual reality affects learning experience positively, and enhances the conditions of transfer of training to happen by for example providing a clear context for the task trained and enabling concrete “doing by hands” experience. Simulation training also seems to have a positive effect to trainee confidence which affects the transfer process by adding personal motivation.

Key words: learning experience, simulation training, transfer of training, virtual reality

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1. INTRODUCTION

This thesis is written in collaboration with KONE Corporation. Thesis intends to answer to research question *how practicing in virtual reality affects learning experience and could it enhance the transfer of training*. The aim of the thesis is to get both quantitative and qualitative research data to KONE and find out if there is potential in virtual reality training in developing employees' competence and making training more cost-effective. I will also discuss any positive effects virtual reality training has on learning experiences and thus possibility of transfer of training. Research material is collected with structured theme interviews and online survey.

Research is done as a part of KONE's internal gamification pilot. The pilot consists of two mobile learning games and HTC Vive based virtual reality simulation, which includes two different training modules. The aim of the gamification pilot is to enhance the competence of current and future employees, and simultaneously implement new innovative ways of training. Aims and connections to company's strategy will be discussed in more detail in the background section (chapter 2). This thesis focuses on the virtual reality training solution as the headline suggests, but the two mobile games of the pilot are mentioned along the journey since the interviewees used them as a reference point in the discussions.

Study is based on HTC Vive virtual reality system, which is computer generated, realistic, interactive and immersive 3D simulation. The hardware consists of head mounted display, headphones and two haptic hand controllers. Virtual reality as a technology has been utilized in training from 1980's (Gigante 1993), but HTC Vive can be perceived as one of the first affordable commercial solutions. Wider and easier utilization of virtual reality technology is possible today also because software engines for the hardware exist; simulation addressed in this text is made with Unity. Virtual reality in general as well as HTC Vive will be discussed in more detail incoming chapters.

Research topic is not only important to KONE as a company to make their training more efficient, but to change the view how we see traditional learning and what kind of effects successful learning experiences have on one's professional expertise. Virtual reality as a technology and as a training environment is greatly researched area especially in aviation and medicine, but in this thesis it will be evaluated how suitable it is to elevator installation. Since the technological side of the virtual reality has been witnessed to suit certain training needs, I'm focusing more on what kind of effects training in virtual reality has on person's confidence and motivation, thus on the whole learning experience and how this all derives to the transfer of training. When addressing transfer of training in this study, I mean person's ability to apply skills learned in virtual reality to real world work. More

detailed definitions to the phenomena will be introduced in chapter 3.2. *Transfer of training*. Training in virtual reality might be one solution to make learning more personal, motivating, engaging, and at the same time provide better learning outcomes.

Since the core theme of the study is learning experiences, it is necessary to define this concept. There is no concise definition to learning experience, because it is complex combination of one's previous experiences, skills and attitudes. It is depended on every persons' individual needs, hopes and values. UNESCO (United Nations Educational, Scientific and Cultural Organization) has defined learning experience as following:

“A wide variety of experiences across different contexts and settings which transform the perceptions of the learner, facilitate conceptual understanding, yield emotional qualities, and nurture the acquisition of knowledge, skills and attitudes. In educational settings learning experiences are ideally challenging, interesting, rich, engaging, meaningful, and appropriate to learner needs. Previous learning experiences are considered to be key factors predicting further learning.”¹

In this thesis my aim is to discuss the learning experience phenomena deeply - taking into account previous skills, attitudes and needs. I'm trying to evaluate the importance of positive and versatile learning experiences to transfer of training. The aim is not to find whether the simulation triggers transfer of training in each training case, because that could have required larger research set up and longer follow up phase. This study focused on the possibilities virtual reality training provides to the transfer of training by affecting the learning experience of the user.

Text proceeds so that first the organizational background will be explained in more detail in chapter 2, followed up with theoretical background and literature review about virtual reality and transfer of training in chapter 3. After background, in the chapter 4, the research method will be justified and the challenges that came up along the process will be covered. In chapter 5 the results of the study are first presented in sort of raw format, but then analyzed and divided into themes in Analysis chapter 6. In the last chapter of the thesis the relevance and importance of the research results will be discussed, and conclusions based on the findings will be made – and finally the plans considering further study will be evaluated. Short summaries of the content of each chapter will be provided in the beginning of the chapters.

¹ IBE (2013). Glossary of curriculum terminology, IBE-UNESCO.
http://www.ibe.unesco.org/fileadmin/user_upload/Publications/IBE_GlossaryCurriculumTerminology2013_eng.pdf
(visited 5.9.2017)

2. ORGANIZATIONAL BACKGROUND

In this chapter I will shed light into KONE as company and the KONE Way of learning. I will introduce KONE strategy and business model and how they connect to this research topic about virtual reality learning. There will also be discussions about other digital learning solutions KONE is using or prototyping currently. This is how we can perceive the context of the virtual reality simulation, and previous learning experiences of KONE employees. In this background section I will refer considerably to KONE's internal materials not available in public. These materials can be found in attachments section. Whenever the information was available in public network, URL references were used.

2.1 KONE

KONE lists its mission to improve the flow of urban life. KONE is the fourth biggest elevator manufacturer in the world² and provides elevators, escalators and automatic building doors, as well as solutions for maintenance and modernization. KONE hopes to make people's journeys safe, convenient and reliable, in taller, smarter buildings. Together with partners and customers around the world, KONE pursues to help cities to become better places to live in. In 2015, KONE had annual net sales of EUR 8.6 billion, and at the end of the year close to 50,000 employees. KONE class B shares are listed on the NASDAQ Helsinki Ltd. in Finland.³

KONE was founded in Finland in 1910 and has manufactured elevators since 1918.⁴ KONE trains its own installation and maintenance personnel, so efficiency and innovation are key words in Training and Competence Development department. In KONE Mission, vision & strategy figure training and competence development places to "collaborative innovation and new competencies" in the "winning with customers" and "ways to win" (Figure 1). New competencies are achieved by developing new and efficient ways of learning, and by enhancing the transfer of training. These values are not written down to KONE strategy as black in white, but of course affect project funding. Good training also affects to the "fast and smart execution" in "ways to win" and both "safety" and "quality" in "culture".

² "Top elevator & escalator companies worldwide in 2015, based on revenue (in billion U.S. dollars)". The Statistics Portal. <https://www.statista.com/statistics/281179/leading-companies-in-the-area-of-elevators-and-escalators-by-revenue/>. 24.7.2017.

³ "Who We Are". KONE commercial website. <https://www.kone.us/about-us/kone-as-a-company/default.aspx>. 24.7.2017.

⁴ "KONE (yritys)". Wikipedia article. [https://fi.wikipedia.org/wiki/Kone_\(yritys\)](https://fi.wikipedia.org/wiki/Kone_(yritys)) 24.7.2017.

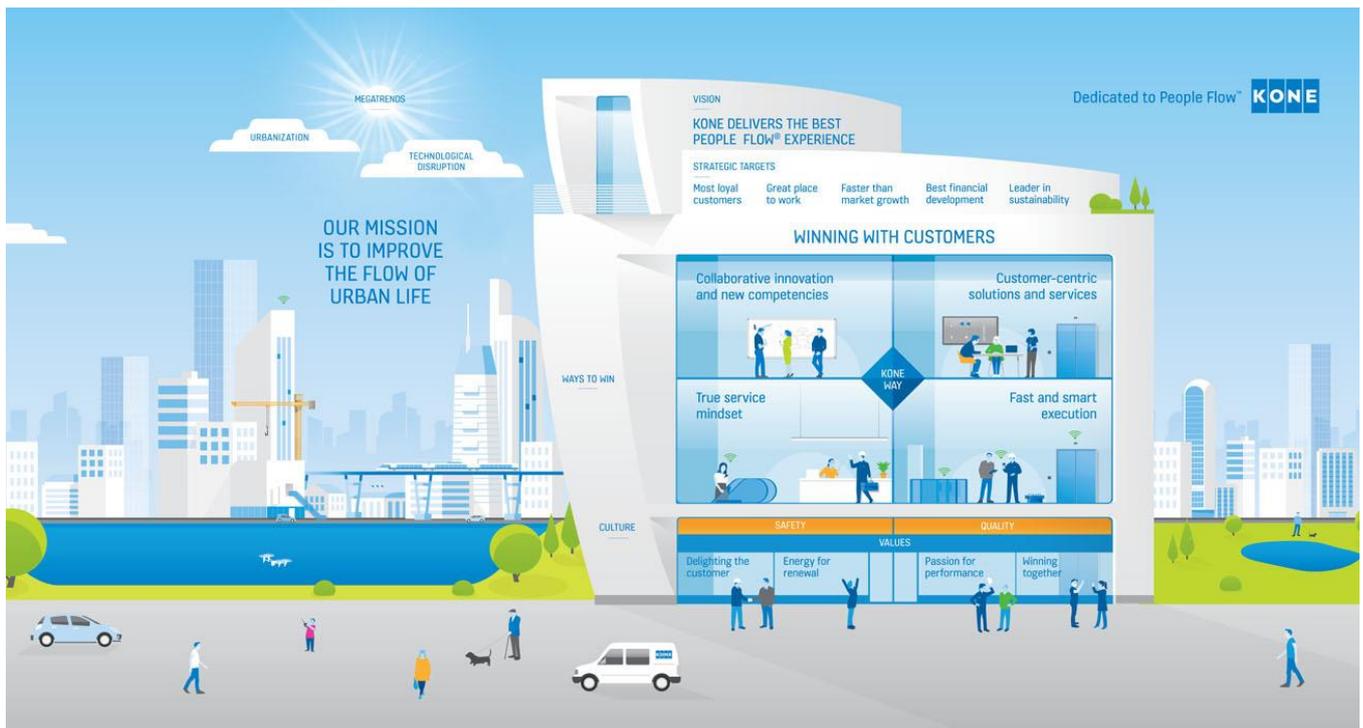


Figure 1: KONE Mission, vision & strategy. KONE Corporation 2017.

2.1.1 KONE Objectives

The objectives KONE hopes to achieve with its 2017-2020 strategy (attachment 1: “*KONE Mission, vision & strategy*”) are: 1) to have the most loyal customers, 2) to be a great place to work, 3) grow faster than the market, 4) have the best financial development in our industry, 5) to be a leader in sustainability.

According to 2017-2020 strategy there are two megatrends impacting KONE’s business environment; urbanization and technological disruption. Urbanization brings more people to the cities and that creates higher buildings and more people flow. This means long term growth potential for new equipment, maintenance and modernization. Technological disruption creates possibility to work, serve and learn in new and smarter ways. This will transform the entire industry according to KONE, so in 2017-2020 strategy company will increase automation, artificial intelligence and new digital tools to change the nature of work. Using virtual reality to train installation personnel falls into this category. To support this claim, the 2017-2020 strategy also states: “*To meet changing customer needs and enable new ways of working, we are investing heavily in new technology*”.

To achieve 2017-2020 strategy’s objectives KONE has listed its values delighting the customers, energy for renewal, passion for performance and winning together. The basics of these values lie in

safety and quality, as we can see in KONE Mission, vision & strategy figure (figure 1). Core values safety and quality are also the main reasons why company is investing in virtual learning environments. More about safety, quality and learning environments will follow in coming subchapters.

2.1.2 KONE MonoSpace® 500

The virtual reality simulation that I am discussing in this thesis is about MonoSpace® 500 elevator model installation. MonoSpace® 500 is machine room-less elevator for residential or commercial buildings⁵. It is the first machine room-less elevator in the world and it also uses KONE EcoDisc motor, which reduces the amount of energy lost as heat.⁶ This is why the installation process differs from elevator models that do have a machine room. MonoSpace® 500 is designed for maximum 15 people and 70 meters of travel distance at most.⁴ Because MonoSpace® 500 is suitable to both residential and commercial buildings, it is a good elevator model to start the virtual reality training. Its generic nature fits many installers' needs and serves a large group of customers. MonoSpace® 500 is also KONE's most produced elevator model, so the cause why this specific elevator model was chosen to this virtual reality pilot is quite clear.

More precise information of MonoSpace® 500, such as location of the motor, is visible in figure 2. The figure shows all the components of the MonoSpace® 500. All the functions of different components are not relevant concerning this study, but the basic functions can be derived from the figure 2. Each of these components are 3D modelled to the virtual reality simulation and function as the real ones. The components, but especially the order to install components vary from one elevator model to another. The order and locations of components installed is crucial point of the simulation, and that's why they are presented here in this thesis. One aspect that had an effect on why just MonoSpace® 500 was chosen to the virtual reality was that KONE already had 3D models of every component of this elevator model, which is not the case with all the models.

⁵ "KONE MonoSpace 500". Kone commercial website. <https://www.kone.co.uk/new-buildings/lifts-elevators/monospace-500/>. 25.7.2017

⁶ "KONE". Wikipedia article. <https://en.wikipedia.org/wiki/Kone> 26.7.2017

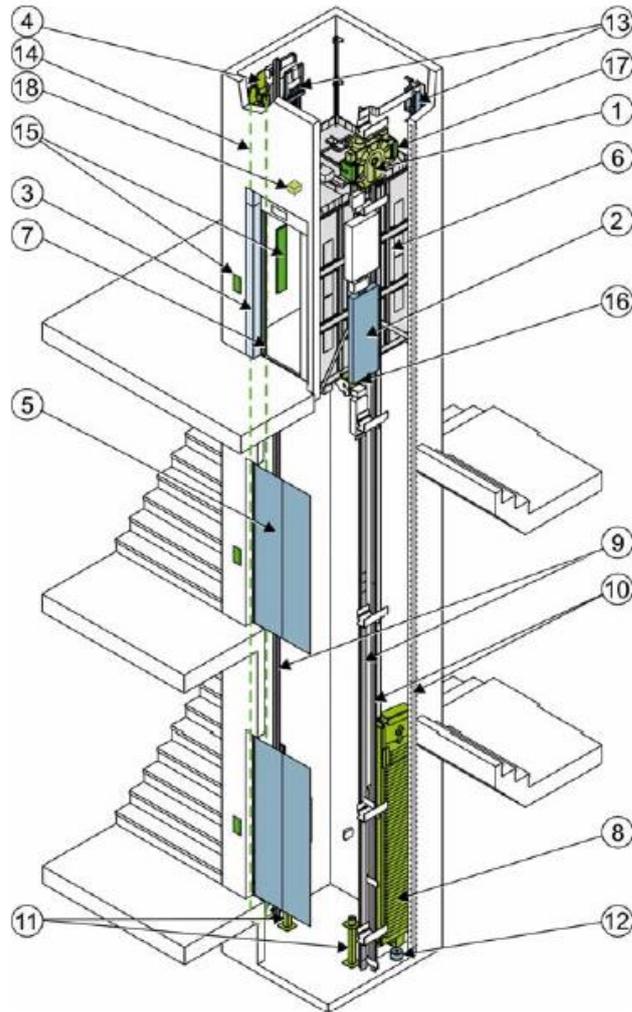


Figure 1. KONE MonoSpace® components, suspension ropes not shown

1	Machine	10	Counterweight guide rails
2	Shaft electrification panel	11	Car buffer
3	MAP	12	Counterweight buffer
4	Overspeed governor	13	Rope suspension points
5	Landing doors	14	Overspeed governor rope
6	Elevator car	15	Signalization
7	Car door	16	Safety gear
8	Counterweight	17	Brakes
9	Car guide rails	18	EBD

Figure 2: MonoSpace® components. 2012 KONE Corporation.

2.2 KONE training

KONE trains its employees mostly internally. Training plans, materials and schedules are made in training and development department with consistent protocol. KONE Training Center is in Hyvinkää, Finland. KONE follows “train the trainer” model, in which every trainer is trained in a training center and then sent to the world to train future employees and subcontractors. Trainers also

translate all learning materials to local language, so that training and development department can avoid extra work. Trainer can also better evaluate the cultural and linguistic context of the local trainees to avoid misunderstandings. Trainers are often from the country they are sent back to do the teaching.

KONE also follows 70-20-10 learning model, which I will be discussing more in next subchapters. The main point of this model is that training should consist of 70% learning by doing (actual work), 20% learning from others and only 10% by formal development and training. Formal development and training is again divided into smaller sections, which will be discussed in chapter 2.2.1 *Blended learning*. To ensure the success of that 20% learning from others, KONE also has “buddy system” to provide each trainee continuous reflection of one’s learning. To strengthen the 70% learning by doing, there are additional trainings every now and then to maintain the expertise and for example avoid safety risks caused by abstraction or carelessness.

Every training and learning path is affected by KONE strategy (figure 1) and company’s core values. New trainings are not made just by request, but instead go through tight protocol which evaluates the benefits acquired from training, considering the resources and other possible solutions to the existing problem. New training isn’t always the right solution to the problem faced in certain department which has requested training. Solution may as well be focusing on better communication in that department. When the topic is accepted as training subject, training plan is made. Training materials are prepared and piloted carefully. Target group, competence, and resources are the three main points that must be taken into account in the training plan.

By taking target group into account when making the training plan, it is possible to design targeted learning experience, which includes group's background information like prior knowledge, interest, motivation, hopes and fears, learning expectations, and basic skills. (Attachment 2: “*Blended learning at KONE, Analyzing the situation, Target group*”) When the target group background info is gathered carefully, it is easier to customize the learning experience for example by picking the most suitable training method according to the training group’s previous accomplishments. Source of this kind of background data is konelearning.com, a Saba-based e-learning platform. I will discuss KONE learning in more detail in the next subchapter.

The second aspect one has to take into account when planning KONE training is competence of the target audience. Competence consists of knowledge, skills and attitude. Skills can be again divided to smaller sections; motor skills, social skills and cognitive skills. Based on the competence of the target group, the learning objectives are decided. To keep the objectives simple, it should be possible

to describe every training with short phrase like “by the end of this session/exercise participants will be able to (action) in (context)”. When the competences are known, it is easier to avoid some problems and obstacles beforehand.

The third point when planning KONE training is the resources. Resources consist of budget, time, subject matter experts and facilitators, equipment, facilities & tools and target group availability. The scope of different work roles is varying from installers to managers and human resources, so of course the facilities and tools vary as much. It is also very different thing to get HR personnel to attend a training in the same classroom or to do mobile learnings between work tasks compared for example field maintenance personnel. This is why carefully planning the resource usage is a crucial part of the training plan.

2.2.1 Blended learning/KONE learning

KONE follows blended learning model, which is represented in figure 3 by example of installer’s learning path. Blended learning model consist of 10 percent of actual training, 20 percent learning from others and 70 percent by on the job learning. Training consists of online sessions, e-learnings and face to face sessions. Learning from other happens via Team Flow site and coaching or learning from buddy, whereas on the job learning is gained by performing the tasks and doing homework. Figure 3 shows an example curricula of blended learning path. I will use this installer learning path as an example of blended learning through the whole chapter. However, there are many other training paths available, but since the virtual reality simulation I’m discussing in this thesis is focused on training installers, this particular training path is most relevant, and therefore a good example of blended learning.

Installer Learning path – Blended model

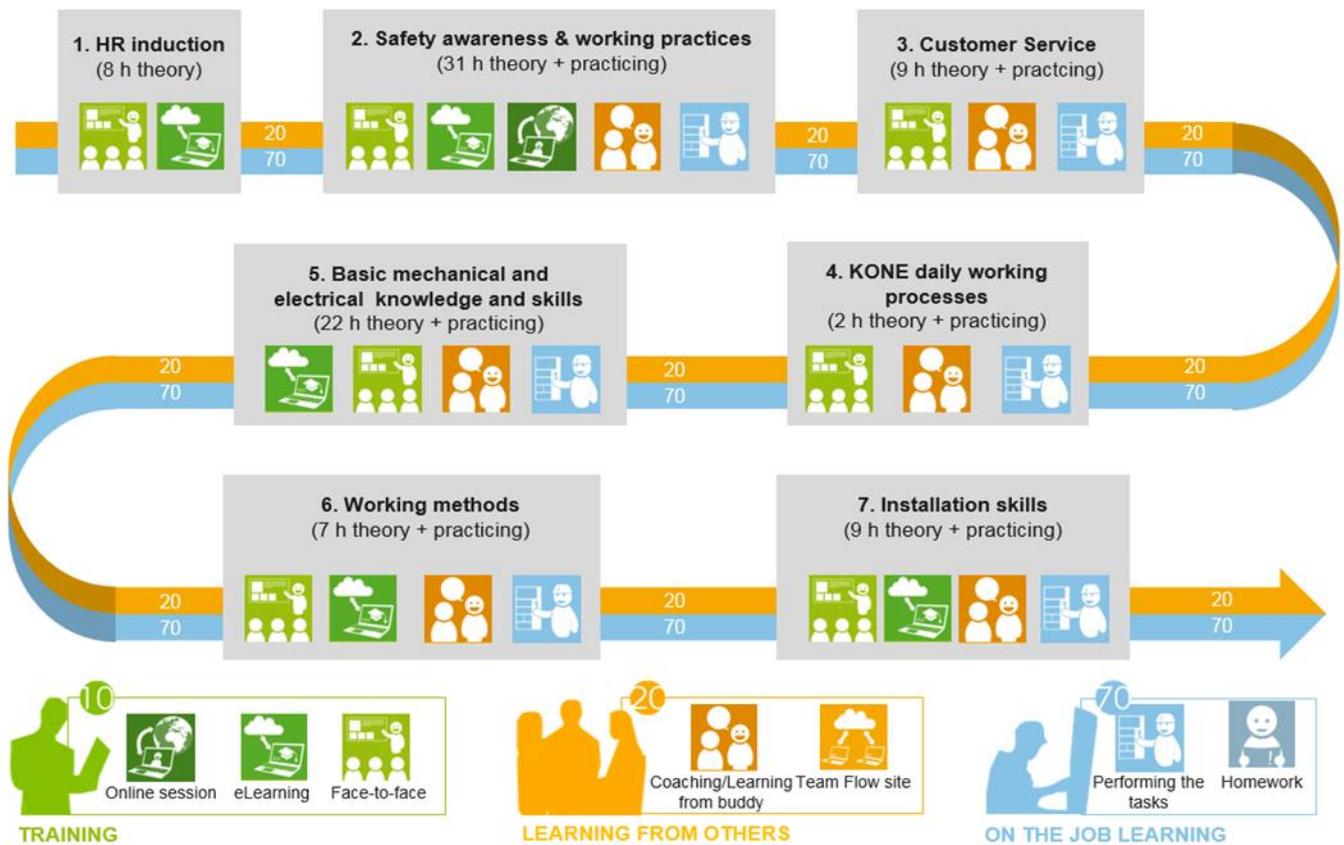


Figure 3: KONE Blended learning model example – installer learning path. (KONE 2016).

According to this blended learning model, majority of learning happens on the job. So instead of trying to teach everything in the classroom or online, the model gives the space necessary to trainees to actually practice their workmanship on the job. This also allows trial by error learning. On the job learning includes homework as well, but it is only a small fragment of on the job learning.

Learning from others is the second largest percentage of blended learning path. 20 % of learning happens from others. In practice this means interaction in social media, mainly in KONE’s own Team Flow site, and through KONE’s Buddy System. The Buddy Program is designed to be part of the KONE Installer learning path with the aim of easing the transition and learning curve of the new or current installers. The objectives of the program are for example to ensure that the installer does his/her job safely and follows KONE’s standards, methods and instructions and maintains high level safety and quality standards. The buddy supports and coaches the trainee, communicates between

supervisor, trainer and trainee and evaluates installer's competence. The buddy system is designed to efficiently utilize learning from others in training.

The actual training itself, the only 10 % of learning, is threefold. Only one part of it is traditional classroom education held by trainers. Competence and Development department defines which parts of the trainings are best as traditional face to face sessions and which can be carried out as e-learning or online sessions. The basics of this training was covered in previous chapter 2.2 *KONE training*. All of the KONE's e-learning happen in konelearning.com. Site contains different kind of e-learning materials; videos, tests, quizzes, lectures and other interactive content. Every employee has access to the site and has some mandatory courses at least at the beginning of the employment or related to specific learning path. Everyone can search materials relevant to them or a manager can prescribe certain courses to employees if necessary. KONE learning is also used to register to classroom trainings and to keep track of one's certifications. While classroom trainings are prepared by training managers, the e-learning contents are made by Competence and Development department or by sub-contractors.

Blended learning path that includes all described above, ensures that installers have the required knowledge and skills to take care of their job safely according to KONE standards, methods and instructions. This guarantees quality products, reliable operation, and customer satisfaction. Blended learning provides the best outcome to KONE when thinking of quality and safety, but also diverse and personal learning experience to trainees.

KONE's way of carrying out blended learning matches to the academia's definition of the concept, however the academic definition seems to be broad. For example, Aborisade (2013) and Tomlinson (2013) define the concept just as a combination on face to face training and teaching with computer technology. According to Musawi (2011) the three main benefits of blended learning are flexibility, accessibility and feasibility. With blended learning all training is not tied into classroom, and students can schedule the tasks/modules according to their needs and at the same time spare money and time on e.g. transportation while the teaching party also saves costs with e.g. facilities. Musawi also states that with blended learning students are able to extend their access to different delivery methods to learn knowledge. These three benefits are also aspects that are appreciated in KONE blended learning.

2.2.2 Gamification

The virtual reality simulation that I'm discussing in this thesis is a part of larger gamification pilot. In addition to the virtual reality the pilot contains two mobile apps. The other is 360 environment maintenance game and the other is about trouble shooting. Both contain several modules and follow KONE's principles and methods of maintenance and trouble shooting. These mobile games are piloted at the same schedule as the VR. Apps' visuals are straight representations of real trouble shooting and maintenance visit (photos and 360° pictures) situations and not just digital illustrations.

KONE has previously carried out some gamified e-learnings, but not actual games to employees to play – however, there is a mobile game targeted for children to learn about elevator and escalator safety. The game is called Max & Bob Above the Clouds⁷. The game is downloadable in Google Play and App Store.

The e-learning platform KONE uses is somewhat gamified. Konelearning, which I discussed in previous chapter, gives grades of one's courses. One can also earn certain certifications and badges, and leave a comment of a course if one prefers to. Usage of gamification connects to KONE's strategy in collaborative innovation and new competencies. Gamification as a concept is used a little bit loosely in KONE's context, because its academic definition is focused on using game design elements to create gameful experiences (mastery, enjoyment, flow or relatedness) in different contexts (Koivisto 2017). How much game design elements are used in the virtual reality training simulation, and what is the difference between gamified app and plain mobile game could be discussed, but since the project was named as gamification pilot, the gamification in KONE's context includes these three solutions that I would subjectively label as training simulation, mobile game and gamified mobile app. Shortly said, when discussing about gamification in this thesis, the term means using gameful elements in training to spark up the training in hopes of motivating the trainees. Gameful element is also nonspecific noun here in academic sense, and refers at lightest to immediate interaction between the user and system, and at most substantial to usage of badges, leaderboards and rewards.

⁷ Max & Bob Above the Clouds. <http://www.kone.com/en/safety-game/> (visited 5.9.2017)

2.2.3 Virtual reality simulation

KONE's virtual reality simulation is made by Finnish subcontractor Upknowledge to HTC Vive system. Simulation is built on Unity. This is the first virtual reality system KONE has ever tried, although augmented reality systems have been utilized in different departments.

There are two different programs in virtual reality pilot. One is an overview module, where the user practices the use of the hand controllers and moving around in the simulation. The tasks are simple; user just has to place the installation modules to the right places of the elevator shaft. The goal of the overview module is to make the user familiar with the virtual reality system and go through the basic phases of elevator installation. The other program is elevator car installation, where user has to go through all the phases of installing an actual elevator car. Simulation has an audio guide, but to perform the installation basic knowledge of the installation process and elevator vocabulary is required. Audio guide is in English. In the simulation user uses all the same installation tools than in real life, but of course in limitations of HTC Vive hand controllers. Used tools are for example screw driver, screws, hoist controller and spirit level. The functions of hand controllers are represented in figure 4 (*HTC Vive Hand control functions, User Guide MonoSpace 500 Installation, 2017.*) Limiting the normal intuitive hand movements to only few different buttons of course makes the installation task differ from reality, but the effect of this is also studied in questionnaire and interviews. Previous studies support the claim that good haptic feedback enhances the feeling of realness in virtual reality and creates stronger immersion by lessening the VR sickness, adding sensory realism and interaction (Buxton 1985, McMahan 2003, Zhang 2016). With this pilot KONE also tests if the current virtual reality technology is developed enough to replicate such complex process as installing elevator.

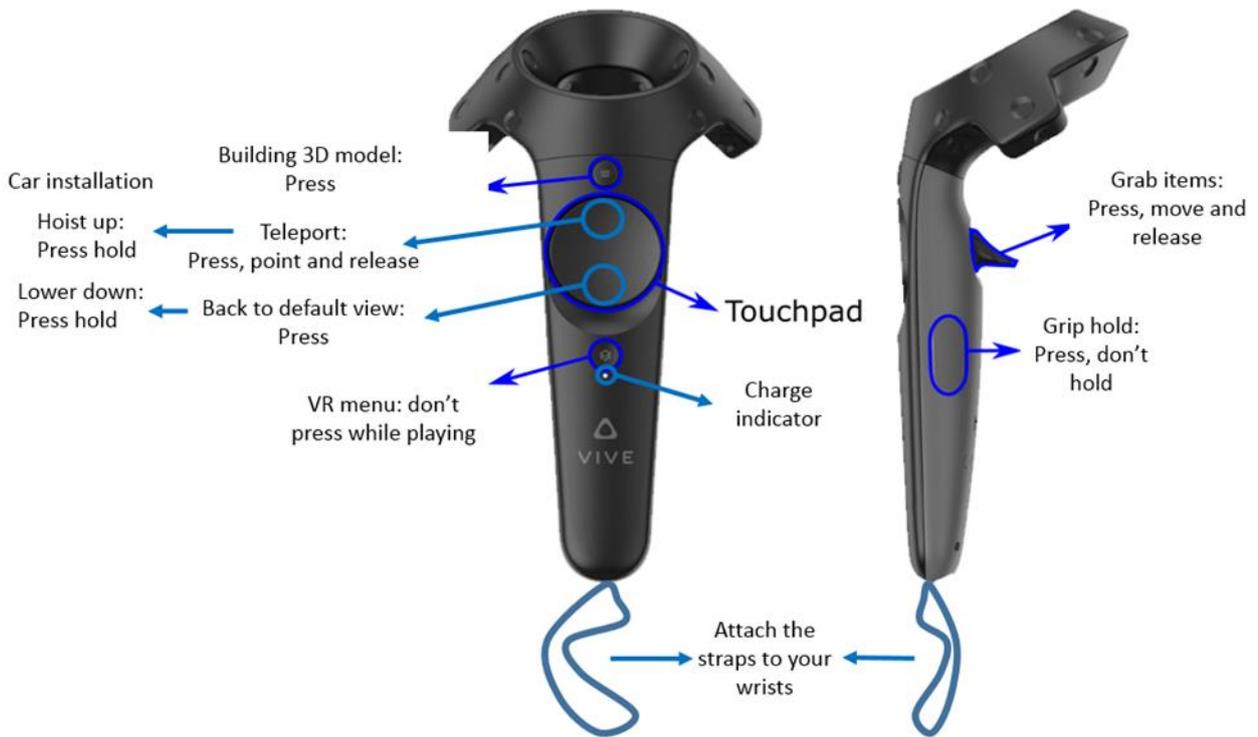


Figure 4: HTC Vive Hand control functions, User Guide MonoSpace 500 Installation, 2017.

Virtual reality system consists of hand controllers, headset and headphones, which are linked to central unit PC and two base stations. Base stations are hoist up by two tripods. Base stations track the movement of the hand controllers and headset. Gaming area forms between two base stations and if user exits the area, base stations can no longer track them. Equipment limits the user's trajectories because of the mass of the headset and headphones, but mostly because the cable from headset to central unit. It is for example possible to the user to trip over the cable. That's why a facilitator is needed to survey every session. System is portable, and gaming area can be adjusted to the size and shape of the room.

3. LITERATURE REVIEW

In this chapter I will go through previous research about virtual reality and transfer of training. I'll introduce both concepts in general and then deepen into more specific means of use and research results. In this thesis the main focus is in utilizing virtual reality in training and transfer of skills learned in virtual reality to the real life. I'm also going to discuss the effect and utilization of VR to business since in industrial setting, the cost-effectiveness of training matters to KONE. In the end of the chapter I'll emphasize the connection of motivation and confidence to transfer of training from virtual reality, but also provide few case examples when training in virtual reality has not caused any observed transfer of training.

3.1 Virtual reality training

Virtual reality is computer generated, realistic, interactive and immersive 3D simulation. Virtual reality technology usually consists of headset, hand controllers and speakers (headphones or 3D speakers), but can also be interactive space with multiple screens. Interactivity is due user's body movement tracking of different accuracies.^{8 910} Virtual reality simulations usually give high-class, immersive visual and audio feedback, and in addition provide variety of levels of haptic feedback through hand controllers or haptic gloves. Virtual reality can also stimulate user's sense of smell or taste, but these senses are more rarely utilized. Gigante (1993) defines virtual reality so, that the emphasis is on the illusion of participation via multisensory feedback devices.

This literature review focuses mostly on virtual reality training and its history. Pros and cons of virtual reality training will be introduced as well as the main problems and possibilities of virtual reality technology concerning training. Problems and possibilities are explained via three different theories affecting the physical experience in virtual reality.

Virtual reality as a training tool has been used from the 1980's, first in United States' military VCASS simulator in 1980 and then NASA VIVED space simulator in 1984 (Gigante 1993). Technological development that led to these training simulators in 80's begun already in the 1960's with *Sensorama*¹¹ from 1962 and the *Ultimate Display*¹² from the 1965. Latest technological development

⁸ Virtual reality. Wikipedia article. https://en.wikipedia.org/wiki/Virtual_reality Visited 9.10.2017

⁹ Virtual reality. Dictionary definition. <http://www.dictionary.com/browse/virtual-reality> Visited 9.10.2017

¹⁰ Virtual reality. Dictionary definition. https://en.oxforddictionaries.com/definition/virtual_reality Visited 9.10.2017

¹¹ Heilig, M. L. 1961. SENSORAMA SIMULATOR. United States Patent Office.

¹² Sutherland, I. 1965. The Ultimate Display. Information Processing Techniques.

sparked especially by Oculus Rift Kickstarter campaign in 2012¹³ made the virtual reality technology accessible and affordable for consumers and smaller organizations than NASA of USA military. Current commercial products are for example HTC Vive, Samsung Gear VR and PlayStation VR in addition to already mentioned Oculus Rift.

Current technology enables variety of kinds of gaming, training, inspecting and designing experiences. Virtual reality has been utilized for example in therapy treating phobias (North, M. & North, S. 2016), in product design to locate possible mistakes before production (Fillatreau et al. 2013), in tourism to provide trips and tours to locations that would otherwise be too expensive or difficult to reach (Guerra et al. 2015) and even in data visualization in stock markets¹⁴. Possibilities seem to be almost limitless. Overall virtual reality is a good tool to experience situations that would otherwise be too expensive, dangerous, harmful to environment or even impossible to carry out. Virtual reality is an effective form of blended learning solution, which can save costs in e.g. training facilities and at the same time provide different insights compared to class room teaching. Blended learning with its benefits was discussed in more detail in subchapter 2.2.1 *Blended learning/KONE learning*. Minimizing the risks related to training and even saving in the training costs is of course something that interests different industries – an example of such situation is e.g. training a new pilot; without the simulation training the first flight attempt could be deadly, and in addition the jet fuel is expensive. Other example of an expensive and dangerous training is elevator installer; building a test elevator is multiple times more expensive than a virtual reality simulation equipment, and mistakes in the building process can lead to heavy parts falling on the trainee.

One of the main problems of past and current virtual reality technology is the virtual reality sickness. Symptoms of virtual reality sickness are for example nausea, headache, disorientation and even vomiting. Virtual reality sickness is very much like motion sickness, but the causes are little different. (LaViola 2000) There are three main theories that aim to explain the virtual reality sickness; sensory conflict theory, postural instability theory and sensimotor adaptation. They are linked to the functions of inner ear. (Lu, 2016) According to the sensory conflict theory the virtual reality sickness is caused shortly said by the mismatching feedback from different senses sensing space and movement. Some of the senses gain feedback from the simulation (eyes and ears) and some from the real world (vestibular system, proprioceptive system, and somatosensory system). This kind of mismatch doesn't fit to the expected sensory pattern, so different levels of uneasiness is experienced depending

¹³ Oculus Rift Wikipedia site. https://en.wikipedia.org/wiki/Oculus_Rift. Visited 20.2.2018.

¹⁴ Carson, E. 2015. QuantVR wants to turn stock market data into immersive virtual reality experiences. TechRepublic. <https://www.techrepublic.com/article/quantvr-wants-to-turn-stock-market-data-into-immersive-virtual-reality-experiences/> Visited 21.2.2018.

on the personal traits. (Johnson, 2005) This theory applies to both virtual reality sickness and ordinary motion sickness experienced in e.g. vehicles. There are several tricks of lessening the sensory conflict, some as easy as just adding a nose to the simulation view¹⁵.

The postural instability theory explains the virtual reality sickness as unfamiliarity of the body situation in virtual reality, which causes inability to maintain control of postural stability. This feeling of not being in control of one's postural stability appears as motion sickness symptoms. (Johnson, 2005) So to avoid virtual reality sickness caused by lack of postural stability control, there should be no noticeable latency in simulation or any surprising changes of view, posture or position.

The sensimotor adaptation affects the virtual reality sickness as long as the virtual reality technology provides experiences that body needs particularly to adapt. Human sensory system adapts to new situations well, but discomfort is experienced first. Level of discomfort depends on the amount of adaptation that needs to be done. Using the virtual reality simulation requires quite lot of adaptation of the body, which can be experienced as unpleasant. Uneasiness may occur again when exiting the virtual world. (Lu, 2016)

3.2 Transfer of training

Transfer of training as a concept means learning a skill or a corresponsive skill in certain training environment and then being able to utilize that skill in real action. According to Kirwan (2009) transfer of training is about application of learning back at work and maintaining that over time. Oxford references¹⁶ define transfer of training, sets some requirements to it, and gives ground when it tends to work as following:

“The facilitation or impairment of performance of a task resulting from prior training on a different but related task. Transfer tends to be positive when the two tasks involve different stimuli and similar responses, and it tends to be negative when the two tasks involve similar stimuli and different responses. When the two tasks involve different stimuli and different responses, there tends to be little or no transfer.”

¹⁵ Stinson, L. 2015. How to Reduce VR Sickness? Just Add a Virtual Nose. WIRED.
<https://www.wired.com/2015/04/reduce-vr-sickness-just-add-virtual-nose/>. Visited 21.2.2018.

¹⁶ Transfer of training. Oxford reference database.
<http://www.oxfordreference.com/helios.uta.fi/view/10.1093/acref/9780199657681.001.0001/acref-9780199657681-e-8526> Accessed 28.10.2017.

This definition suggests that for transfer of training to happen, only the triggered responses of the task being trained need to be similar to the desired task. When discussing about transfer of training in virtual reality, we don't need to settle for just responses but we can also simulate the stimuli of the desired task. In incoming chapters I'm going to discuss the transfer of training as a psychological phenomenon and open up the transfer process, efficiency and previous case studies.

Transfer of training is widely researched topic, but not only in educational sense but in business too. Companies are interested in how well their investments to employee training pays back – what do they profit from it? Educational institutions are likewise interested in optimizing programs by for example decreasing the training time and reducing teaching resources. Kirwan (2009) notes in his book that attempts to invest in training often come to nothing if the desired results are pursued with means that in the end doesn't cause any transfer or only create it partially. Transfer of training needs certain setting to work, and those requirements I'm going to clarify in this literature review by also presenting cases where transfer was not successful.

3.2.1 Transfer process

Below I'm going to present Baldwin's and Ford's model of transfer of training (1988). Model represents the inputs, outputs and conditions of training. Baldwin's and Ford's model becomes especially important when inspecting and evaluating the effectiveness of transfer in situations where the task trained is simple and not necessarily work related. Transfer of training is not just a manual process, but consists of trainee characteristics, training design and work environment. That's why for example the study named *Training in virtual environments: transfer to real world tasks and equivalence to real task training* that Rose et al. (2000) conducted is not optimal to actually measure transfer of training, because they made the test persons perform really simple spatial tasks without any context, for example benefiting at work. In Rose et al.'s study, the work environment part of the transfer model is more or less cut off. Baldwin's and Ford's model shows that transfer of training process is strongly context tied.

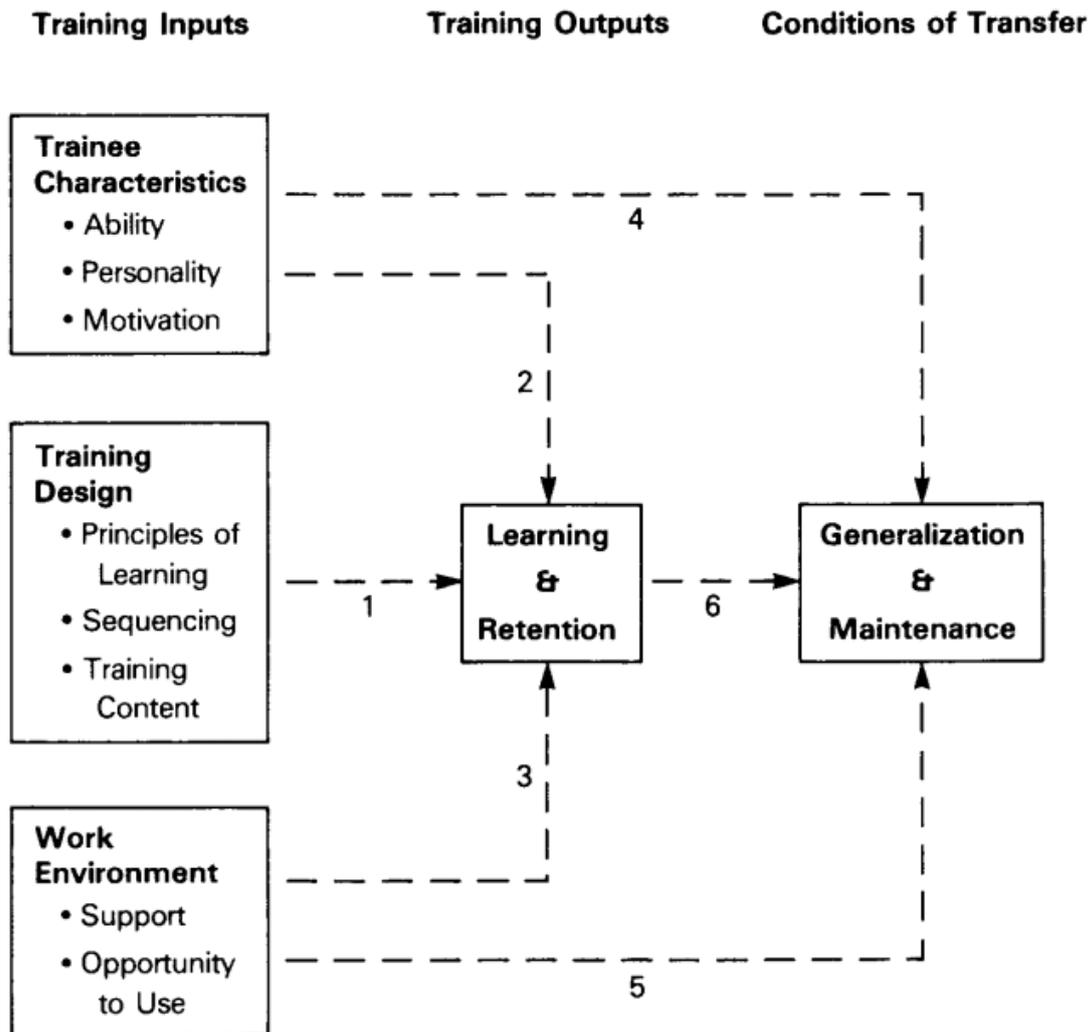


Figure 5: A Model of the transfer Process. Baldwin and Ford, 1988.

To create such training program that provides best preconditions to transfer process one needs to consider learning & retention and generalization & maintenance –parts of the Baldwin’s and Ford’s model. Transfer of training can’t happen if the trainee gets no opportunity to utilize skills learned in training, like the figure shows: opportunity to use is connected to skill maintenance. Baldwin’s and Ford’s model suggest that even though the transfer of training process depends partly on trainees’ personalities (trainee characteristics), most of the process factors can be affected with good learning plan and schedule (training design and work environment).

Kirwan’s (2009) model for transfer of training (*figure 6*) follows the same basics as the Baldwin’s and Ford’s model, but puts more emphasis on the trainees’ motivation and learning abilities and less on the content or training method design. This model highlights even more the context bound nature of the transfer of training. Transfer process requires support from trainer and peers, personal

motivation to learn and such organizational settings which enable the trainee to be able to transfer the learned skill in to the practice.

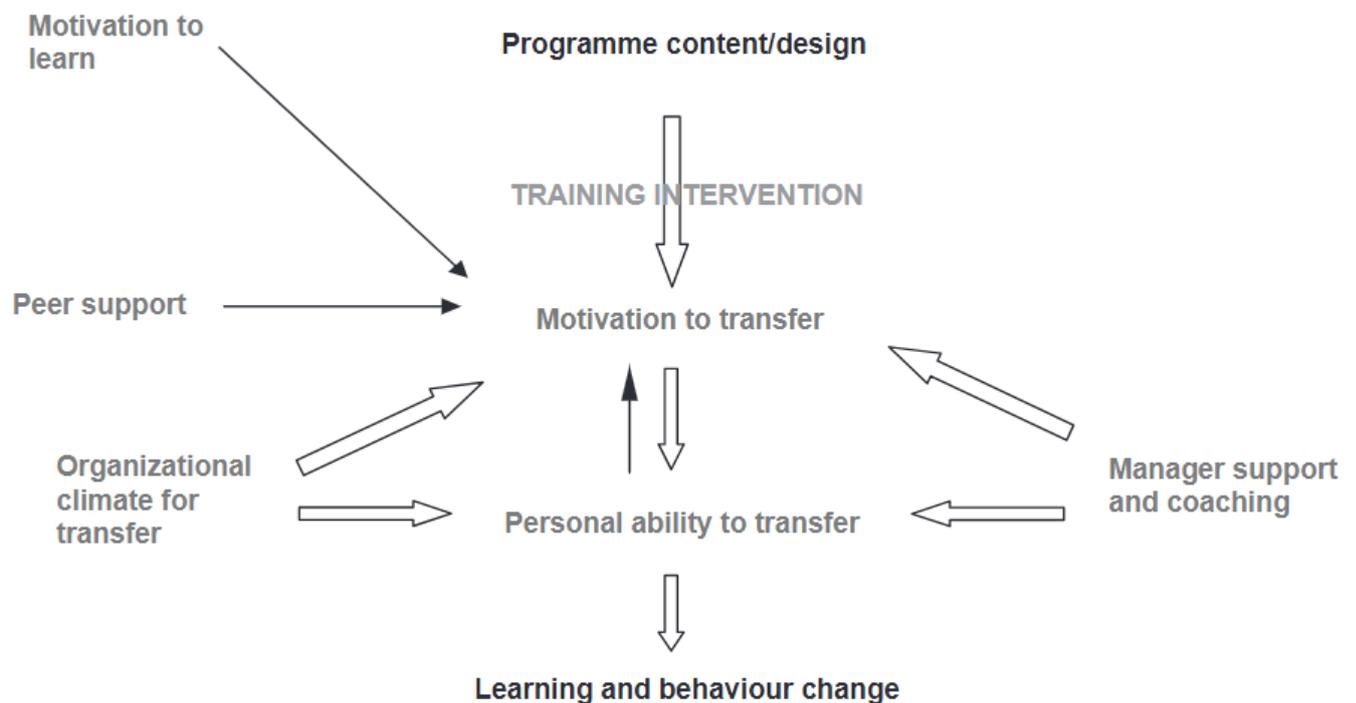


Figure 6: How to Improve Learning Transfer. Kirwan, 2009.

3.2.2 Transfer efficiency

Renta-Davids et al. discuss transfer as efficiency in their study *Transfer of learning* (2014). Transfer as efficiency refers to trainees' ability to directly apply what they learned previously in a new setting – which is the same approach I have used in this thesis. They also present the idea of transfer as innovation, which is trainees' ability to learn new skills and gain knowledge to understand their environment in a different way. However, transfer as efficiency may be easier aspect to study, or at least it is better approach to research transfer of training from virtual reality in case of elevator installation learning experiences.

According to Renta-Davids et al.'s study, training efficiency is part of the training design and is described as “characteristics of the training design that helped trainees to learn the contents.” The study showed that training efficiency was strong predictor of transfer of training. While this might

sound a self-evident result, it points out that there can be some specific aspects in training design that create better transfer than other training design solutions. This again emphasizes the idea that the transfer of training is not only depended on trainees' personality, and that the transfer can be affected and enhanced by training design choices.

3.2.3 Psychological aspects of transfer

I have briefly addressed the psychological aspects of transfer of training in previous subchapters, but in this chapter I'm going link the transfer phenomena to motivation and confidence. Confidence to perform a job related task seems to build up by allowing trainees to make mistakes in training process and learn from it. Ivancic and Hesketh (2000) conducted a study where they compared errorless, guided error and error training in driving simulation to each other and to the performance in a driving test. Errorless training was straightforward simulation without danger of trainee making mistakes, guided error training included a facilitator and in advance decided example mistakes with solution proposals whereas the error training allowed trainee to do mistakes in simulation and figure out a solution by themselves. Error training in driving simulator led to a greater trainee confidence and best results in the driving test. Based on this study it could be argued that confidence gained by trial and error training leads to a better transfer of training.

Another take on learning and confidence to transfer of training is Currie's study *Linking Learning and Confidence in Developing Expert Practice* (2008). This study states that confidence gained by training enhances employees' motivation and willingness to develop their expertise further. And like was already presented in chapter 3.2.1 *Training Process* the trainee motivation is one factor affecting the transfer of training. Also new graduate nurses reported that training in clinical simulation enhanced their confidence to perform emergency operations. Nurses themselves evaluated that the confidence gained in simulation training would have a positive transfer effect to real working life even though the study itself didn't include a follow up phase. (Kaddoura, 2010)

There are plenty other cases where the connection between confidence and motivation to transfer of training is being recorded. For example, Ryman and Biersner (1975) found out that trainee confidence decreased the dropout rate of a navy diving training and enhanced the course completion whereas Baumgartel et al. (1984) discovered that motivated trainees who believe in the value of training are more likely to apply things that have been trained to their everyday work.

Based on these previous studies presented here, it seems like trainee motivation leads to better transfer of training, and at the same time practicing work tasks in simulation with possibility of trial and error learning leads to greater trainee confidence, which again motivates the trainees to apply the skills learned in working life.

4. RESEARCH METHODS & THEORY

In this chapter I'm going to explain the research methods and theory I chose to use in this thesis. Material collection and analysis methods were chosen to best answer the research question, factoring in time and resources available -which in this case meant limited time but versatile resources. In an ideal scenario there would have been time to actually research the transfer of training for example by comparing two different control groups; one of which received virtual reality training and other that didn't. In this study however, I'm analyzing the possibilities of transfer of training in virtual reality via learning experiences. To get a good coverage of that, I chose to collect research material by conducting a survey and 5 theme interviews with total 9 interviewees. People answering the survey were test persons of KONE's gamification pilot from different countries. Interviewees are mostly Finnish installers, because I didn't have time to fly to our other pilot locations to do the interviews. We discussed with our gamification team about the possibility to conduct the interviews via Skype, but dismissed the idea eventually. I will discuss the reasons behind this decision in more detail in subchapter *4.3 Interviews*.

This thesis is a case study, in which I use both qualitative and quantitative research material collection methods to conduct thematic analysis of the results. Research material collection methods I chose are survey and theme interviews, in addition to the literature review of previous research. When choosing the material collecting methods I had to think about KONE's whole gamification pilot, since the testers would also have to answer to two other surveys about mobile apps. I will shed light to this process more in subchapter *4.2 Survey*. In incoming subchapters, I will transparently open up the whole process of choosing the research material collection and analysis methods and actually conducting the study. This methodology section has been the hardest part of the thesis, since it took longer than expected to get the pilot started and surveys to roll out, and the choosing of the just right analysis method was a long journey.

4.1 Methodological starting points

In this thesis I'm going to do thematic analysis of the research results. Thematic analysis aims to find themes and patterns of behavior (Aronson, 1994). I'm going to divide the research results into themes that indicate certain behavioral or attitude related patterns that have some kind of an effect to the possible transfer of training in virtual reality or the virtual reality learning experience over all. In this study I follow Aronson's (1994) description of thematic analysis, which consists of collecting data, transcribing the conversations, identifying the data and connecting it to the classified patterns,

combining and cataloging related patterns into sub-themes and finally building an argument for choosing the themes based on previous research. Based on this process Aronson (1994) recommends formulating a story to make the results easier to follow for the reader. Other possibility to structure the thematic analysis would be theme index, where the approach is less story-like and more of a collection of different themes found from the research material.¹⁷

Thematic analysis is mostly used for qualitative research, but I'm looking for some added value by combining both the qualitative and quantitative data collection methods, which is the way the case studies like this are usually made (Yin, 2014). Denzin (1978) calls this triangulation. Data triangulation is using variety of data sources –qualitative, quantitative or both –and collecting the materials by different methods (Niglas, 2000). Reason behind this is to get as good perception of this vast phenomena in such limited time. I could have had usable results by using either of my data collection methods, but by using both I got materials that support and complete each other. Because the research question of this thesis is so experience oriented and open, I think it is justifiable to use two different data collection methods to ensure the reliability of the results. However, triangulation may cause some problems to the research process. According to Bryman (1992) quantitative and qualitative research have different preoccupations and that's why they may not be tapping the same things even if first thought so. Researchers may also get themselves into a conflict with the study if the results of the qualitative and quantitative materials don't confirm each other. I acknowledge these issues and take them into account when analyzing the results and making conclusions. Aim is to find same kind of themes and categories from both material samples and analyze them together. This may be an unusual method to analyze quantitative data, but it supports the research question and the goal of the thesis.

Thematic analysis as a qualitative research method was chosen because qualitative methods aim to answer questions like *how* and *why* (Denzin et al. 2005), which are essential in my research topic to get the best possible understanding of as complicated phenomena as transfer of training in virtual reality. Like stated right on the headline, this thesis is a case study, but I am treating the *case study* more of a research strategy than a research method.

¹⁷ Teemoittelu. Opinnäytetyöpakki. Kajaanin ammattikorkeakoulu.
<http://www.kamk.fi/opari/Opinnaytetyopakki/Teoreettinen-materiaali/Tukimateriaali/Laadullisen-analyysijatulkinta/teemoittelu> Visited 29.9.2017

4.2 Survey

I chose survey as one of my research material collection methods, because with it I could relatively easily get a lot of data to specific questions. According to Routio (2007) questionnaire is a good way to reach target audience if among other things the research problem is well defined, questions don't need clarification and the range of possible answers are known in advance. He also points out, that digitally distributed surveys may create bias to the results due to lack of internet access. This was not the problem in this study, because all testers get to answer the survey with their KONE mobile phones or with a tablet available in the testing room. Target group was also decided beforehand, so desired audience was reached with no bias. Target groups in Singapore and Philippines was selected by local executives. Requirements for the installers were good enough English skills, which were evaluated by the superiors. The installers and other personnel were informed about the possibility to participate to gamification pilot, and the participation was entirely voluntary. In Germany and Norway, the requirement was fluent enough English, but otherwise the test persons consisted of employees who happened to have time to test in the piloting days.

Formatting the survey started by editing already existing version of virtual reality pilot's questionnaire. This first version was made by the gamification team. It was a simple and short survey which aimed to find out possible problems of the simulation. We tested both the simulation and the survey during summer months before entering the actual piloting phase. Based on additional questions made by people who tested the simulation and survey, I edited some of the questions, added new ones and dismissed some. In addition to this, we arranged a testing event one week before the beginning of the pilot. In this event testers got to test the final version of the virtual reality software and the improved version of the survey. After this I made some final tweaks to the survey, so that everyone would certainly understand the questions right.

Survey was made with Webropol. This platform was chosen because KONE already uses it with internal surveys and other feedback forms, and because it scalable to all devices. Each of the test surveys were made to separate entries instead of editing the existing one to avoid mixing up the results. Test persons could answer the survey either at the test space by tablet or with their own mobile devices preferably still in the test space. Those who chose to answer by their own device, could reach the survey with URL link or QR code printed to the test space wall. There were 119 people who answered to the survey in five different locations; Finland, Singapore, Germany, Philippines and Norway. Testers could choose to do the survey anonymously or write down their KONE email to participate a draw. Prizes of the draw were distributed locally and depended on the local organization. Since the piloting countries changed a little bit during the pilot, 46 % of the respondents answered

“other”, as can be seen in the figure 8. Five answers out of those 55 “others”, were some sort of misunderstandings, because they included two Singapore, one Hannover (Germany) and even two “training rooms”. 25 % of respondents who chose “other” were from Norway and 65 % from Philippines. According to this statistic, most of the respondents were from the Asia-Pacific area and the rest from middle and northern Europe. In reality there were some more testers in Finland, but we had some problems with the feedback tablet, so about 3-5 survey answers didn’t get through at all, and it took some time to us notice the fault. At the time we noticed that the amount of “Finland” answers had not risen, even though we definitely had testers in Hyvinkää and I personally watched them to fill in the feedback form, it was already too late, because we didn’t have the contact details of those persons who had been testing the simulation.

1. Where did you use the VR simulation?

Number of respondents: 119

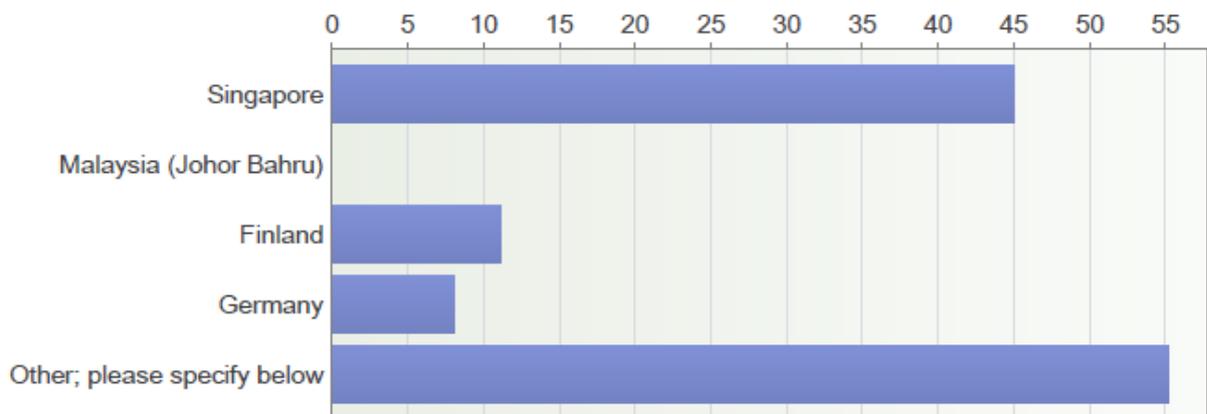


Figure 8: Where did you use the VR Simulation?

While testing the survey before starting the pilot we managed to create some sort of technical error, so that one respondent’s answers were submitted three times. I reached this person, and he didn’t submit his answers that many times on purpose. Because this kind of situation happened once, it is possible that it could happen again. This has to be taken into account when analyzing the survey results. It is almost impossible to sort out this kind of results if the user has not left their email or any textual feedback to the open field questions. Extra submits can be sorted out of the answer pool manually, if for example double (or triple) email address is noticed. This kind of fault is very

unfortunate, because it can make someone's feedback matter more. If we think for example situation where person rates the grade of the simulation 0 and compare it to the situation where they rate it 0 four times, the effect to the overall grade is much bigger.

In ideal case I would have asked more questions in more detail, but like I mentioned in the beginning of the chapter, the survey needed to be kept quite short, because the people testing the virtual reality simulation also participated testing of the other two gamification applications that are part of KONE's gamification pilot. Other aspect that had an influence on the length of the survey was that the survey was meant to be answered at the testing space to ensure that each and every one would certainly submit their answers. This practice was recommended by my colleagues, because based on their previous experiences many "forget" to answer to feedback surveys if the answers are not demanded right away. This of course means that the survey can't be very time taking. Survey questions and feedback answers can be found in the attachment section (attachment 3).

Even though the language of the feedback survey was English, the German respondents for some reason answered to the open questions in German and not in English. I don't personally speak German nor does anyone in my department in Hyvinkää, so I had to contact training administrator in Hannover to translate the German feedbacks to English. These feedbacks are visible in attachment 3 both in German and English. Survey answers also contained one reply in Finnish. This reply is also visible in both Finnish and English, translated by me.

Work roles of the respondents were diverse. As hoped, biggest group was elevator installers (38 %) and the next biggest groups were either other technical (24 %) or non-technical (23.5 %) role (see figure 9). Respondents of the survey were not only installers, because it is relatively hard to get installers out of the field and come to a training center due to tight construction schedules. Also, not every installer from Asia-Pacific countries has fluent enough English skills. That is why the pilot sample contains so much other roles than installers, even though the VR simulation is about installation. We couldn't get too picky with the test person in risk of getting too little responses.

3. What is your primary work role?

Number of respondents: 119

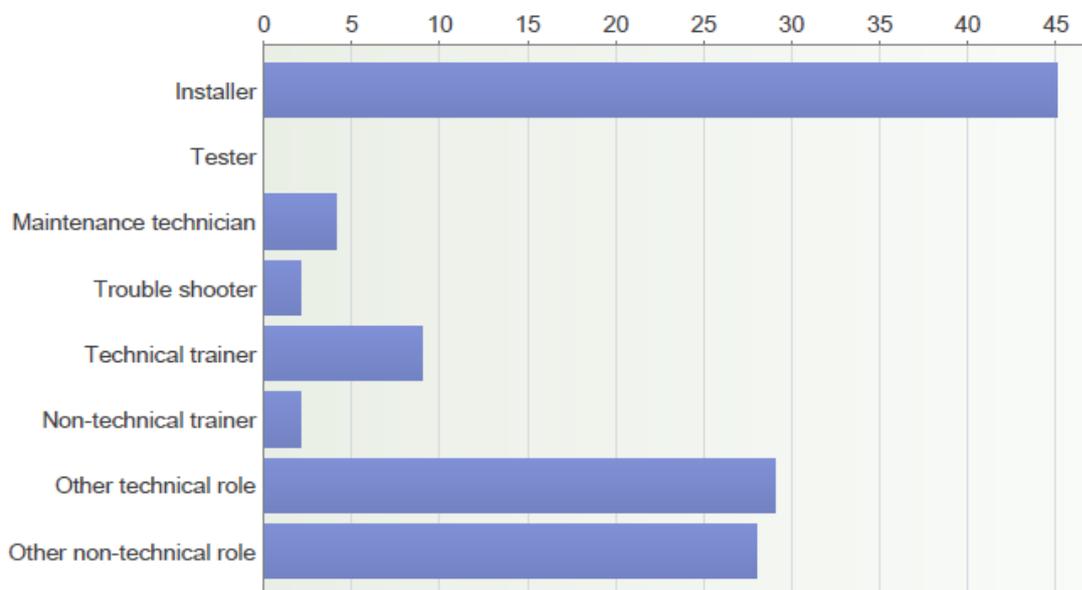


Figure 9: What is your primary work role?

4.3 Interviews

Theme interview questions followed the same structure than the survey. The purpose of the interviews was to get deeper into the same theme. I wanted to hear actual experts' opinions of usage of virtual reality when training elevator installers, and also map the reasons behind their vision. These theme interviews play a supporting part to the survey results. According to Kvale (1996) "The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say." This is exactly what I'm looking after with the interviews. I wanted to bring up meanings, attitudes and previous experiences behind the basic answers we get with the survey.

All the interviews were done in Hyvinkää. I recognize that by doing the interviews only in Finland and the surveys in five different locations creates a bias. We discussed with the gamification team about the possibility to do more interviews via Skype or get somebody else to do the interviews in Singapore and Germany. I refused to agree to the option of somebody else conducting the interviews, because theme interviews are informal and conversational, so that even if I would have had the interview tapes, the results of the conversations would have not been what I expected and needed for

this thesis. Besides, doing the interviews would have required some level virtual reality expert, which we really don't have too many in KONE. Skype interviews were dismissed partly because of the same reasons. The purpose of the theme interview is to create a good structured conversation between the interviewer and interviewee, and that might be hard when there's no common fluent language. Many of the Singaporean or German installers do not have fluent enough English skills to discuss as abstract concepts as the theme interview requires. Interview questions are mostly very abstract and the discourse is in attitudes and experiences, so I preferred to perform them in the mother tongue of the installers, which is in this case was easiest to carry out in Finnish. I could have done the interviews also in English, but since there were almost none native English speaker in the target audience, it was not an option. Doing the theme interviews in Finland in Finnish was a compromise set by circumstances to make the process easier to all parties.

The interview questions are attached to the attachment section. Over all the interviews consisted of 22 prepared questions and improvised and defining questions at the interview situation. Like I mentioned when discussed about the survey respondents, actual elevator installers are really hard to get out of the field. Partly because this problem but also to get versatile interview data, the interviewees' roles were installation supervisor (former installer), installer and industrial school student (installation). There were total nine interviewees. Three of them were former installers currently working as an installer supervisor, four were students studying in KONE's industrial school to become installers and two were full-time installers.

Originally, I planned to do every interview one interviewee at the time, but it turned out that the interviewees themselves preferred to come in pairs because of their working schedules and rideshares. Eventually I did only one interview so that there were just me and the interviewee, and four interviews so that there were two interviewees at the same time. Interview lengths varied from 19 minutes (the single interview) to 52 minutes. All interviewees were males and their age varied from 19 to 52 years, with average age of 34.7 years.

Interview process including the virtual reality testing took 1.5-3 hours per session depending how fast the interviewees adapted the hand controllers and navigating in the virtual reality simulation, and how lengthy the conversation was in the interview phase. Each session begun with me picking up the interviewees from the lobby and escorting them to Training Center. Interviewees were provided coffee, chocolate and biscuits, and in the end of the session a lunch voucher to the local cafeteria if they wanted. In the beginning of the session I introduced the project and myself, and told what we are going to do during the session and in which order. Before starting the actual testing, I informed the interviewees about the safety issues of the simulation and showed how the hand controllers work.

The testing phase consisted of Overview module, which takes circa 10 minutes to play, and Elevator car installation module, which takes 25+ minutes to play. Time taken by Elevator car installation module depends greatly on how used the tester is to technology and games. Testers who do not play games in their free time or otherwise use technology, are much slower completing the virtual installation. Then the Elevator car installation module may last even as much as one hour. In double interviews the testers sifted turns, so that they both did the Overview module first and after that the Elevator car installation. This way the interviewees got a little break from the headset use and could learn from each other's performances. Simulation view was projected to the smartboard so that I as a facilitator could help to the tester if problems occurred, and also because it was helpful to the other tester to see in advance the simulation logic and tool usage.

When both interviewees had played through the two modules, we sat down and began the interviews. I informed them verbally that the interview will be recorded, and the record will be used only for my thesis and not for example handed to interviewees' supervisors even if the supervisor for some reasons would demanded so. Interviewees accepted that they would appear in this thesis by work title and age, but otherwise anonymous. Totally anonymous interviews would have been hard to arrange, since the virtual reality room was in the department where I worked, and my colleagues could see who I brought with me into the room and recognize them by the face since everyone works for the same company. So, if somebody working in KONE wants for some reason to find out which interviewee said what about this virtual reality pilot, with little effort it might be possible. However, the interview materials do not contain anything that I would label harming, but of course personal information about learning habits, attitudes and something even about free time activities. Before starting the actual interview, I also briefly introduced the topics we were going to discuss and encouraged them to not just answer my questions but also ask back and discuss.

I recorded the interviews with my personal mobile phone using free app called "äänitallennin" and saved the audio files to my phone, Dropbox and OneDrive. Transcribing was done by me. Transcribing process was the most time taking phase of this thesis, partly because I had to translate the parts used in this thesis text from Finnish to English. In the interviews that consisted me and two interviewees talking, the lines were color coded so that I could keep in track who is talking.

5. RESULTS

In this chapter I'm going to discuss the results of the study by starting with the survey and then moving on to the interviews. Results will be presented in form of Webropol figures when it comes to the survey, and general summary and direct quotes when going through the interview results. Deeper discussion about the results will be done in the chapter 6. *Analysis*. Statistics presented already in the method section will not be discussed here. General feedback given in the end of the survey is visible in attachment section (attachment 3).

5.1 Survey results

This thesis aims to answer the research question *how practicing in virtual reality affects the learning experience and could it enhance transfer of training*. These survey results provide relevant background information to this question, but also answers to questions which relate to the development of the simulation and success of the pilot – which are not crucial material for this thesis, but mandatory part of the project. To summarize the results, the simulation was well liked and perceived useful. Not a single grade for measuring the successfulness of the simulation in 1-5 Likert scale was below 4.

4. What is your primary competence area?

Number of respondents: 119

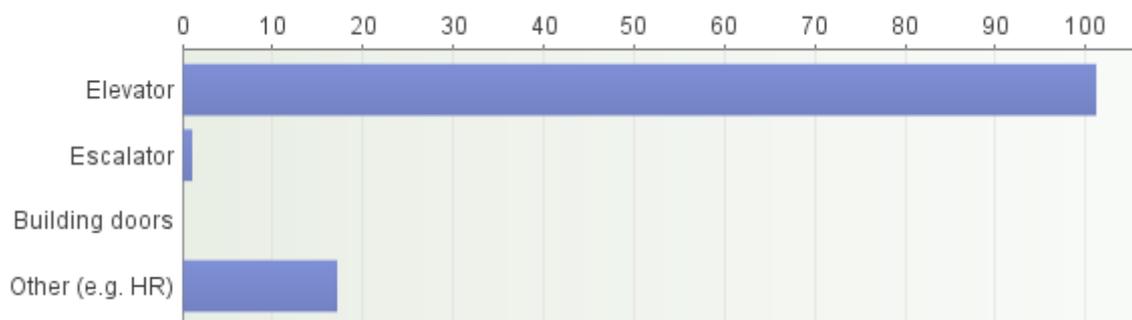


Figure 10: What is your primary competence area?

Figure 10 shows that the vast majority of respondents work with elevators, but the sample also contains employees from other competence areas such as HR. This is important background

information since the simulation is about elevator installation, and now we can assume that almost all of the respondents are experts with elevator technology.

5. How long is your work experience in your role?

Number of respondents: 119

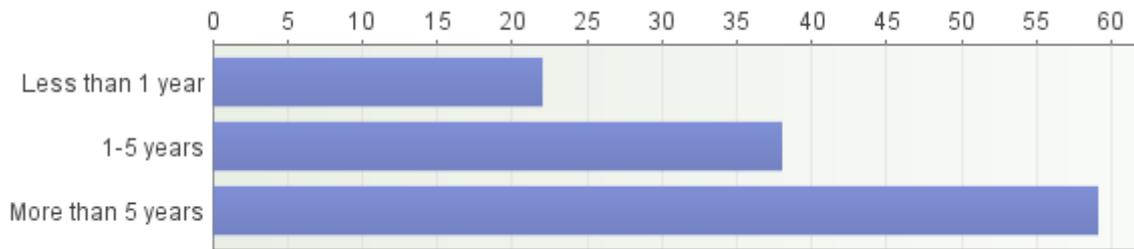


Figure 11: How long is your work experience in your role?

Most of the respondents were experienced KONE employees, as we can see from figure 11. Only 18 % of the respondents have worked less than a year in their role. Based on this statistic it is safe to assume that the respondents have had time to build a profound perception of elevator installation, methods and practices to evaluate the virtual reality simulation as experts in their field.

6. Have you tried any virtual reality simulation before?

Number of respondents: 119

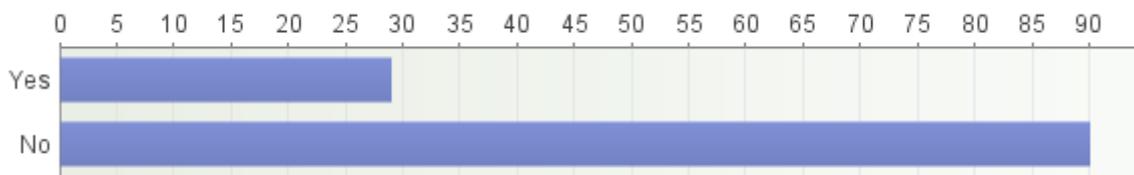


Figure 12: Have you tried any virtual reality simulation before?

According to figure 12 majority of respondents have not tried any virtual reality simulation before. The number of respondents that do have tested some VR before is still surprisingly high. 29 persons out of 119 reported testing VR before. This question was asked to better evaluate the novelty effect of the results. Question also relies on respondents' own definition of virtual reality simulation. When planning the survey, we figured that after testing the elevator installation simulation the respondents

have good enough perception and definition about VR to answer this question without further examples or definitions given by us.

Based on these answers it could be said that the commercialization of virtual reality technologies has indeed spread if 24 % of audience consisting mainly of elevator workers has used some sort of VR – presumably in their free time since this is the first time KONE utilizes virtual reality, and like we saw in previous figure (figure 11), most of the respondents have worked in their role in KONE for several years, so the possibility of respondents testing VR in their previous work doesn't seem very likely. This is however just an interesting side note of the study.

7. Do you play digital games in your free time?

Number of respondents: 119

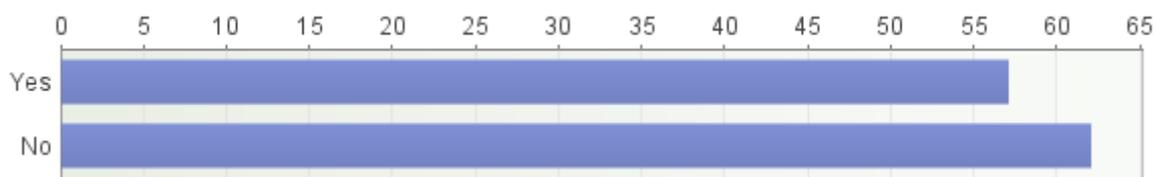


Figure 13: Do you play digital games in your free time?

The answers of question 7 of the survey (figure 13) were divided almost evenly in favor of “no” - answers. 52 % of respondents do not play digital games in their free time. This question was asked to evaluate the connection of one's technological skills and interest to games and compare it to how good or useful the simulation was perceived. I was not expecting this positive feedback of the simulation since I somehow thought that there would be more general resistance towards technology transmitted learning methods. That's why I wanted to map the digital free time habits of the respondents.

8. Which VR MonoSpace 500 installation modules did you play?

Number of respondents: 119

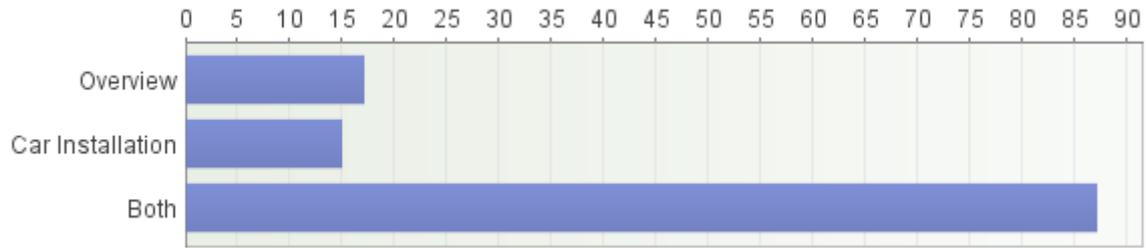


Figure 14: Which VR MonoSpace 500 installation modules did you play?

Not everyone had time to play through both modules, but luckily the majority did (figure 14). I am assuming that those 15 people who marked that they only played the Car Installation, first watched someone else to do the Overview module, since all the facilitators were instructed to start the sessions with the Overview because the Car installation can be too challenging to start with if the hand controls and simulation logic are not practiced first. Those who had time to play only the Overview module can't have as profound perception of the training simulation than those who performed the car installation in the simulation, because the overview is just an overview of the MonoSpace 500 installation phases – like the name suggests. Luckily, we added this question to the survey, so that the fact that not everyone actually played the Car installation can be taken into account when analyzing the results. Ideal situation would have been that every tester had played both modules, but since we couldn't monitor every session or guarantee exactly same circumstances for everyone, we listed this question. The sample of respondents who played both modules or only Car installation is still however great enough to consider the results reliable.

9. How long did you play the game? (minutes)

Number of respondents: 119

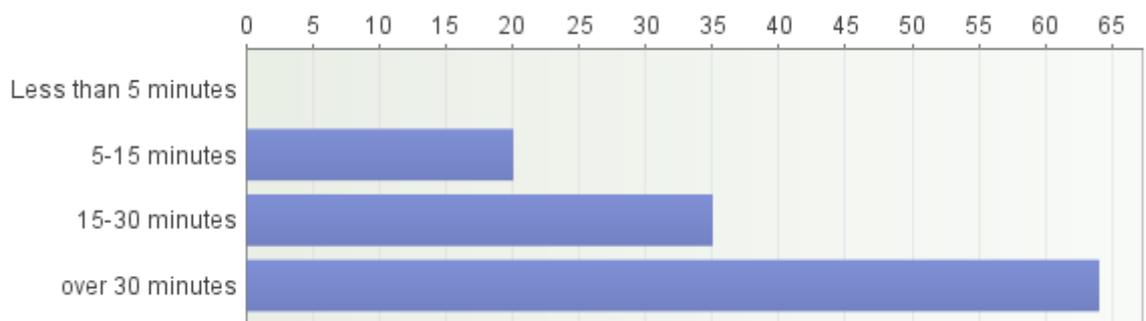


Figure 15: How long did you play the game?

Results that figure 15 provides were important to the virtual reality pilot, so that we could evaluate if there is right amount of content in the simulation and simply know how much time one session takes. Most respondents reported playing over 30 minutes according to figure 15, and only 17 % answered that playing the simulation took only 5-15 minutes. If the respondent played only the Overview module, time taken is much shorter like stated in previous section.

10. Did the VR simulation system work smoothly?

Number of respondents: 119

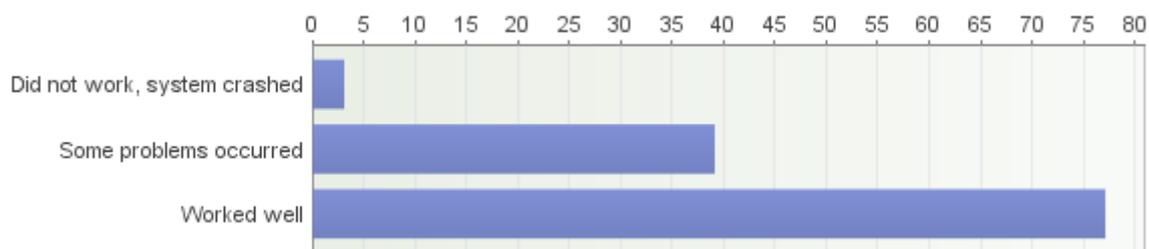


Figure 16: Did the VR simulation system work smoothly?

We had some problems with the simulation software pre-pilot, so this question had to be added so that if there were system crashes or other serious malfunctions we would know that they affect other answers of this survey. Luckily respondents reported only three system crashes, which is of course three too much, but could have been worse (figure 16). “Some problems occurred” however is not so severe malfunction as system crash, and may be partly caused by misunderstanding of simulation instructions or facilitator guidance. Whatever the case – simulation system should be working more smoothly according to this feedback, because even though majority (65 %) stated that simulation worked well, a simulation aimed for training purposes requires somewhat higher reliability rates than this to avoid user frustration and to keep the focus on the content and not on the technology.

11. VR environment: how well do you agree with the following statements?

Number of respondents: 119

	1	2	3	4	5	Total	Average

VR environment is easy to navigate	0	2	9	59	49	119	4.3
VR model with elevator and building is good	0	0	5	49	65	119	4.5
Hand controls and functions are easy to use	0	2	13	48	56	119	4.33
Total	0	4	27	156	170	357	4.38

Figure 17: How well do you agree with following statements?

Figure 17 shows that respondents found the VR model with elevator and building good with high as 4.5 score in scale from 1 to 5. The correctness of the 3D models is crucial part of a training simulation because often the focus is on the detailed content and not on big or abstract concepts where the showing an idea would be enough. Elevator car installation is very detailed and precise task, where every screw and bolt matters, so to practice that operation the simulation needs to be correct and realistic. According to this feedback, the simulation software is successful with its models of elevator and building, since not only because the high overall score, but because only 5 people rated the models as average, and zero respondents thought they were below average.

Respondents also answered that VR environment is easy to navigate with overall score of 4.3 and hand controls and functions are easy to use with 4.33. These answers included more average scores than the 3D model question and two below average answers (score: 2). This is good result because we can't greatly affect the HTC Vive hand controls or how to use them in navigating in the simulation, but the simulation model is in our hands.

12. Did you encounter virtual reality sickness (nausea, dizziness etc.)?

Number of respondents: 119

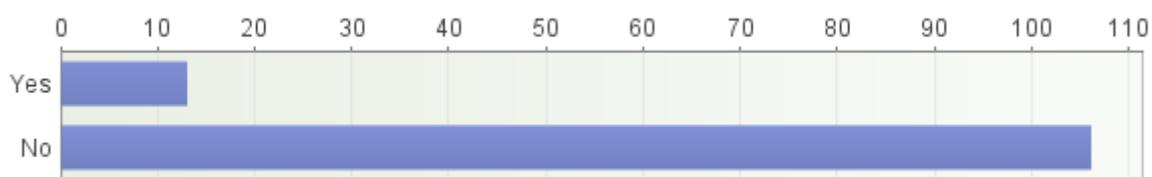


Figure 18: Did you encounter virtual reality sickness (nausea, dizziness etc.)?

13. Description of “Yes” answer: what kind of symptoms did you have?

Number of respondents: 12

- If I move too fast, I feel the dizziness.*
- Something is new*
- Dizziness*
- I have glasses. After I have finished my job, I had a problem with my spatial view.*
- None*
- Dizzy little*
- Feel a little dizzy*
- Colours too bright, nausea*
- Dizziness when the surrounding moved, I almost fell on the floor*
- vähän huimausta kun lopetti*
- Some nausea when sitting on the car roof in the end of the session*
- Little nausea*

Like discussed in the section 2. Literature review, virtual reality sickness can occur due to sensory conflict the VR devices create. Virtual reality sickness can vastly affect the learning experience in the simulation, so we asked the respondents to describe briefly their symptoms if they felt some level of VR sickness. Only 10 % of respondents encountered VR sickness and described it mostly as dizziness, but few of the testers used word “nausea” and one even told that he almost fell to the ground. These are common symptoms of VR sickness. Facilitators were instructed to warn the testers beforehand about the dizziness and stop playing immediately if any nausea occurred. Since the VR sickness cannot be totally avoided with current technology, this was relatively satisfying result, because 90 % of the respondents did not have any VR sickness symptoms. This gives an opportunity to the users to focus on the simulation content and not to distractions like nausea or dizziness.

14. How well do you agree with the following statements?

Number of respondents: 119

	1	2	3	4	5	Total	Average
Instructions were good and informative	0	3	9	49	58	119	4.36
General structure is good and support learning	0	0	5	51	63	119	4.49
Separate tasks are good and support learning	0	1	5	57	56	119	4.41
Simulation could be used as a part of installer training	0	0	4	33	82	119	4.66
Things learned in simulation could be useful in real life work	0	2	5	48	64	119	4.46
Total	0	6	28	238	323	595	4.48

Figure 19: How well do you agree with the following statements?

Highest rating in this Likert scale question set was the one measuring the suitability of the simulation in installer training. 69 % of the respondents rated 5 for the claim “*Simulation could be used as a part of installer training*” and the overall score of the claim was 4.66, which was the highest score of the all questions in the survey. Respondents either thought that simulation should be used in training or were neutral about it, zero below average answers were received for this question. All the other questions about simulation’s quality in training purpose were also rated high.

To address the possibility of transfer of training, we asked a statement “*Things learned in simulation could be useful in real life work*” which scored 4.46 with only two below average answers. Respondents also thought that the separate tasks which the simulation consists, are good and support learning (score: 4.41) as well as that the general structure of simulation is good and support learning (4.49). Lowest, but still good score came from the claim “*Instructions were good and informative*” (4.36).

15. Learning tasks difficulty level

Number of respondents: 119

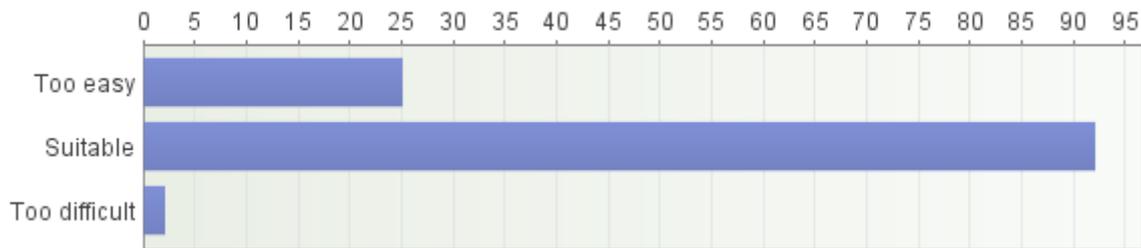


Figure 20: Learning tasks difficulty level

According to figure 20, majority of the respondents thought that the difficulty level of simulation is suitable (77 %). Only two respondents thought that the simulation was too difficult and 21 % reported it being too easy. Based on this the simulation could afford more challenging functions in the future.

16. What was your overall impression?

Number of respondents: 119

	1	2	3	4	5	Total	Average
My overall impression	0	0	6	43	70	119	4.54

Figure 21: What was your overall impression?

Overall impression question didn't get any below average ratings the total score being 4.45 according to figure 21. Novelty effect sure had some sort of an effect to this score, but at least can be said that none disliked it.

17. Did you learn anything new that you haven't learned with other learning methods?

Number of respondents: 119

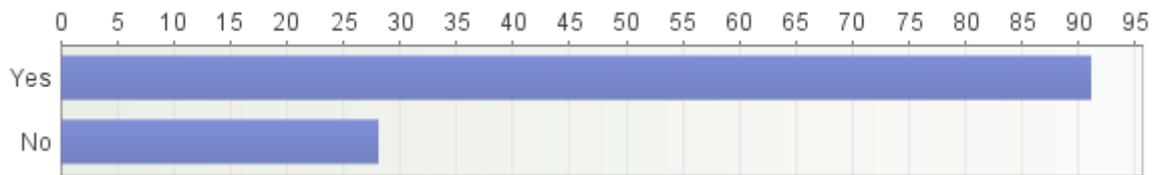


Figure 22: Did you learn anything new that you haven't learned with other learning methods?

Most of the respondents felt that they learned something new in the simulation which they thought they couldn't have learned with different learning methods according to figure 22. This question was asked to find if virtual reality as training tool would bring some added value to training considering that almost all the training in KONE already includes some sort of technology mediated training. This result was surprisingly positive because almost all the respondents already were some level of experts about the simulation content and still felt that they learned something new.

18. Would you recommend this game to your colleague?

Number of respondents: 119

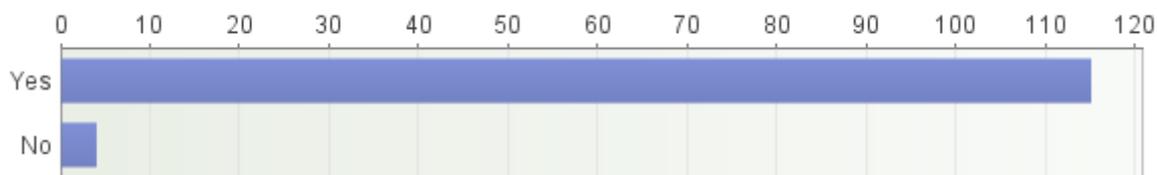


Figure 23: Would you recommend this game to your colleague?

The final question of the survey was the classic *Would you recommend this game to your colleague?* 97 % of the respondents would indeed recommend the simulation to a colleague which tells a lot how well liked the simulation was.

5.2 Interview results

Interview data consists of total 620 minutes of structured conversation after test sessions. I'm not going to go through each question we discussed with the interviewees, but the ones that count the most when keeping the research question in mind. Interview results are not so unequivocal as the

survey results, but some similarities can be found and conclusions made. Results relating to the learning experience are mostly covered in the analysis chapter.

There were total nine interviewees. They were all male and aged between 19 to 52 years. Six of them had tried some virtual reality for varying purposes before, but only two of them described the experience as gaming. Other four told that the experience was more observing than participating. Six out of nine is surprisingly high percentage for interview persons to have tried VR before, especially compared to the survey results. However, this fact may lessen the novelty effect of the interviewee answers and help them focus on the training possibilities of VR and not on the technology itself. In addition, six out of nine interviewees reported playing digital games in their free time – partly different six persons than those who had tested VR. Two of those who do not play in their free time said that they have played something in the past, and only one interviewee told that he has never been interested in any kind of games and thus never really played anything. When the majority of interviewees are familiar with common game logics, it of course affects how easily the simulation logic is embraced and the hand controls learned.

All the interviewees agreed that the training simulation should be part of the installer training path. One installation supervisor thought that the simulation could affect installers' work commitment by enhancing safety at the working site:

"Yeah, I believe that the simulation would have a positive effect to the longevity of careers, because the safety issues sticks hard straight from the beginning [from the simulation] and certainly affect the actual work."

Safety was theme that was discussed most in every interview, but especially all three installation supervisors emphasized it. They shared their own experiences how they had learned by trial and error to not hit their heads to certain places or drop tools to their toes, and wished things could be done differently. The possibility to train the installation without change to do the procedures in wrong order or neglecting safety standards seemed to be best quality of the simulation according to the supervisors.

"It [the simulation] would be good for the new fellas so that there wouldn't be that much of the mistakes in the actual job. Let's do the mistakes here in the classroom and then practice them away".

Industrial school students, the future installers, started reflecting the usage of the simulation based on their own very current experiences. They discussed how lost they had been the first time in the field and how different it was compared to their mental images formed in classroom lectures:

“If you have never been in the pit before and get to train with this simulation, you’ll definitely have better understanding about how things work in the site, and which component goes where compared to just listening in the classes.”

Since the topic of the simulation was the expertise area of the interviewees, during the interviews the testers commented and proposed changes to several things related to either software or hardware of the simulation. Most proposals related to highlighting the safety aspects already mentioned above. Even though every interviewee were ready to implement the simulation as such to new installer learning path, many of them suggested that more aggressive functions to stress safety should be added. Three interviewees proactively proposed some flashing red light and loud alarm sound to be added if the simulation user tries to do break any safety standard. Interestingly enough, partly same people commented that the learning experience in the simulation was pleasant because there was no rush to do the tasks, the audio guide instructed steadily and user didn’t get punished if they didn’t get the bolt to the right place in the first try. This hints a little that the testers necessarily weren’t so sure what do they actually value in good training simulator. Still, no other contradiction arose from the interview material, and I do believe that the opinions of the interviewees are valid references for evaluating the quality of simulation and possibility of transfer of training.

One obvious aspect that came up in the interview discussions was the lack of gravity in the simulation. Some components and tools used in installation are heavy, so that the position how installer picks them up affects the back health and other ergonomics. Some bigger components, e.g. car floor, require separate wheels or other assisting tools to get into place. Without spatial feeling of gravity, it is impossible to simulate the effort required to perform those tasks. This is something that most of the interviewees listed as the negative aspects of the simulation. They joked how after training in simulation the new guys might be quite surprised when coming to field first time and realizing that counter weights actually weight something. This is unfortunate limitation of the current technology, but didn’t seem to affect the overall experience too much.

6. ANALYSIS

This chapter contains analysis of the survey and interview results presented in previous chapter 5. Analysis focuses on the learning experience and factors that somehow affected to it, and to the possibility of transfer of training happening through the simulation presented. Analysis will be based on previous literature and theories presented in the literature review chapter 3, and aims for finding themes to address the research question. Thematic analysis is done by finding the themes from the interview discussions and backing them up with the survey results. Themes sought will be such that indicate certain behavioral or attitude related patterns that have some kind of an effect to the possible transfer of training in virtual reality or the virtual reality learning experience over all.

In addition of getting feedback how the simulation concretely worked and how it could be utilized in the future, it was relevant to know what kind of learning experience it provides. Interviewees described the learning experience mainly as positive, but the reasons behind the positive feeling weren't opened proactively. Based on interview discussion two themes functioning sort of a headlines arose:

- 1) Personal attitudes and values
- 2) Virtual reality technology used

These two themes can be divided further to subcategories, which will be discussed more deeply in next subchapters. Personal attitudes and values relate to the pain points of elevator installation, KONE training methods and preferred ways of learning and working whereas the VR technology theme was discussions and feedback of the system as an enabler of training and which parts of the software and hardware are acceptable in this kind of work related context. Both themes can be derived back to transfer models presented in literature review. Personal attitudes and values represent the trainee characteristics part of Baldwin and Ford's model, whereas the virtual reality technology used can be interpreted as the training design and training program parts of the Baldwin and Ford's model, and as content/design part of the Kirwan's model. In other words, these themes that arose from the research material are essential aspects of transfer of training process backed up by previous research.

6.1. Attitudes and values

Personal values and attitudes affected the learning experience in training simulation. Two subthemes of the overall discussion related to interviewees' values and attitudes were "doing by hands" as a core

value in learning and working, and a bias towards digital learning methods. In this chapter the “doing by hands” discourse will be introduced first, and in the end of the section the bias will be explained.

One of the core values in working and learning of the interviewees’ seemed to be doing by hands. Each interviewee reported that they learn the best by doing by hand. They perceived the learning experience with VR simulation positive, because it apparently fell into the doing by hand -category. They elaborated for example as following:

“With that [the simulation] you learn better how to build the car than when they explain you that in this phase you install the floor and now the walls etc. With that you get to put them into right places by yourself, so it sticks to your mind better concerning learning.”

“I liked the learning experience and actually it also occurred to me [referring to the other interviewee saying he got sweaty] because you’ll get to move in that way, like actually move, and not just wave hands and things go on automatically. You’ll get to move, avoid objects, look under different parts... So it was really positive thing!”

We as a gamification team found it surprising that the interviewees perceived the simulation as doing by hands and placed it in totally different category than mobile learning games and eLearning materials they had tested previously in KONE, because despite the interviewees’ attitudes the simulation still obviously is a technology based learning solution. Discourse that came up in the interview discussions was that learning by doing is the right and only way to truly adapt skills – at least skills relating to elevator installation. One of the installers even stated that “*All learning happens in the field*” but admitted that theory is good support for the practice.

I did ask the interviewees about their attitudes towards digitalization, eLearning and gamification, but didn’t ask them to compare the VR simulation to other KONE solutions. Interviewees proactively emphasized the quality of the simulation by comparing it to other digital training materials they had tried. Industrial school students had tried out our two mobile games mentioned previously in this thesis, and thought that they were not intuitive to use and the experience consisted more of wondering how the game works instead of performing the actual tasks. After lengthy discussion between two industrial school students they came into a conclusion that both mobile games would be better in virtual reality, because in VR you can actually do the tasks. One of the installers compared the simulation to eLearning materials he had studied and stated that if we really need to “do training stuff with computers”, VR is much better solution because of its interactivity and because “you get to do

the tasks by hand."¹⁸ He said that eLearnings lack interaction and sense of progress, thus he gets bored halfway and just clicks the materials through.

Even though the interviewees seemed to value doing by hands and mentioned eLearning materials and other forms of digital learning solutions as opposite of the virtual reality, when I asked their perceptions of digital learning, gamification and digitalization, most of them answered in positive manner. They were familiar with these phenomena and saw them mostly as good and helpful things. One interviewee described that digital learning, gamification and digitalization are good when they help people to perform better, faster or easier in their work and free-time, and bad when they are just added there because it was possible and thus just complicate things. To me it seems that there is a conflict between the answers I got when asking insights to these digital phenomena compared to the discourse the interviewees used when talking about efficient and good ways of learning.

Originally the whole interview structure was built on my assumption of especially older installers' being reserved about new VR technology and thus not necessarily liking the idea of elevator installation simulation at all. Even though I was at some level right them not being the greatest fans of eLearnings and mobile games, it was big surprise that any reserved mind settings they may have had about technology, didn't reach the virtual reality and make the learning experience reluctant, unpleasant or frustrating.

Survey results don't seem to give a reason to doubt the value of virtual reality training being in the "doing by hands". In the open feedback section of the survey the respondents wrote for example that they were positively surprised about the simulation and they would recommend it to the installer training (even though this was already asked in the survey questions, they just said it again with their own words). One respondent stated that: "*The VR was really good and that users will really learn the installation methodology even before they go to the actual site*" which is well in line with the thoughts of the interviewees.

This doing by hand theme seems to be linked to the confidence gained in this kind of training. Industrial school students described their feelings of "being lost" the first time in the field and thought the simulation would be really helpful to avoid that, like already discussed in chapter 5 results. If we compare this result to the literature review made, we notice that skills gained from training simulator increase the feeling of confidence related to the task in hand (e.g. Kaddoura 2010 & Currie 2008) and confidence is studied to lessen the dropout rate of trainees' (e.g. Ryman & Biersner 1975) which is

¹⁸ There are several Finnish expressions for "doing by hand". Interviewees have used different versions each, but every one of the expressions translates to doing by hand or doing by oneself.

remarkable aspect for KONE since the trainees are trained internally and don't come to work as ready installers from external institution. One tool that is used to measure the success of new trainees and quality of installation overall is first year call out rate (FYCOR). It is statistics of maintenance call outs from the first year of certain installer; it measures the quality of the training the installer has received and also their commitment to the job. One main goal of launching the virtual reality pilot in KONE was to affect the FYCOR. Based on the interview and survey results there is clear ground to expect the simulation training to give confidence to the trainees and that confidence should add work commitment based on previous studies.

One possible previous research result that could partially support this finding of doing by hand being so liked form of learning for installers, is the study by Ivanics and Hesketh (2000) presented already in the literature review section. They concluded that error training, where the trainees get to do mistakes and find their own solutions to problems (learning by trial and error), leads to best training results compared to guided error or errorless training. Maybe this doing by hand discourse is linked to the possibility of trial by error learning.

6.2 Technology

Because learning experience in virtual reality depends greatly on the technology used, it was necessary to discuss how this specific hardware was liked. Chapter 2.2.3 *Virtual reality simulation* includes more detailed information about the HTC Vive setup we used for the training simulation. Interviewees told their insights about the hand controllers and if they felt any virtual reality sickness. Like already mentioned in the beginning of this chapter, surprisingly many of the interviewees had tried some virtual reality system before, so they had previous experience to compare. VR technology was not discussed only when I asked those specific questions about hand controllers and virtual reality sickness, but the interviewees brought it up as the second main theme, which is natural considering how exotic technology it is in everyday life. This VR technology theme can be further divided into two subthemes, which are the software and hardware of the system.

All the interviewees thought that the hand controllers were good enough for the purpose, and one even mentioned that the trigger button is a really intuitive mechanism for grabbing an object. Specific question that was asked about the hand controllers was “*Did you get realistic feel about the simulation with the hand controllers*” which was answered by yes’ and explanations. Mostly the explanations were from the “didn’t bother” -side, such as:

“Yeah, they worked logically enough. There were up and down buttons, and the one with what to grab. You know, I don’t know how otherwise they could have done it.”

“I think that the controllers are good when you are holding the tools, the trigger button is really good, because with it you drill, bolt and use the hoist controller. It is OK.”

Three interviewees mentioned that they experienced the headset wire disturbing and movement restricting, and complained that the wire made it harder to keep focused on the simulation itself. Two of them proactively suggested solutions to the problem by hanging the wire from the ceiling so that it wouldn’t be on the floor disturbing one’s steps, and asked if wireless headsets exist. Headset wire was perceived disturbing even though I as a facilitator tried my best to straighten the wire and keep the wire away from testers’ feet.

Virtual reality sickness relates strongly to the technology used, like already discussed in chapter 3.1 *Virtual reality*, so we discussed about any feelings of nausea, dizziness or uneasiness with the interviewees. Two interviewees emphasized that they never get travel sick or sort, and only one interviewee said that he felt little funny when taking off the headset, but otherwise the experience was pleasant to everyone. One of the interviewees stated that he didn’t get dizzy because there was horizon in the simulation, which indeed affects the virtual reality sickness. Based on the interview results, it can be concluded that virtual reality sickness was not disturbing the learning experience. The training simulation is steady paced and does not include any wild movements, so the funny feelings that one interviewee and some survey respondents mentioned might be caused by sensimotor adaptation described in chapter 3.1 *Virtual reality* and thus won’t disturb in the future if the users get to practice in the simulation more.

Discussion and feedback that related to the simulation software were more superficial comments about for example the outlook of the hoist controller, amount of screws that need to be drilled when installing certain parts etc. This kind of conversation took a lot of space of the interviews even though there were no major mistakes in the simulation content, but since the content is so close to the interviewees’ everyday life, they of course paid much attention to even the smallest details. *“Did you notice that part when...”* was a popular phrase during the interviews when the interviewees discussed with each other. I would describe this discussion as a professional curiosity rather than important analysis of the transfer possibilities and suitability of the simulation in the installer training program.

7. DISCUSSION & CONCLUSIONS

My research question was how practicing in virtual reality affects learning experience and could it enhance the transfer of training. Answers to the question were sought by a case study with elevator installation training simulation by interviewing previous, current and future installers, and conducting multicultural survey with KONE employees in piloting areas. Results of the survey and interviews were analyzed together with previous research literature of the topic.

Based on the research results, it is safe to say that in this case practicing in virtual reality affects the learning experience positively by providing concrete “doing by hands” experience, which seems to be most appreciated form of learning amongst elevator installers. Virtual reality training seems to enhance the confidence of the trainees and help them to visualize the components and dimensions in the elevator shaft, and thus perform their work better in real life conditions. Conditions to transfer of training to happen when practicing in virtual reality are favorable, because:

- 1) The simulation has a clear context
- 2) The simulation is connected to trainees’ own work
- 3) Trainees’ have an opportunity to utilize skills learned in the simulation in their work
- 4) Trainees’ have peer support to practice such training method
- 5) Training design is downright and based on the exact same 3D models that are used to produce the real product
- 6) There is clear organizational climate for change

Both main transfer of training process models discussed in the literature review section highlighted the importance of a context in transfer of training. With elevator installation training simulation designed for elevator company’s employees’, the context leaves no room for doubt where, when and how the things learned in the simulation are going to be utilized. According to Baldwin and Ford’s model (1988) opportunity to utilize the skills learned in one’s own work create better ground for transfer of training to happen. Both Baldwin and Ford’s model and Kirwan’s model (2009) list peer support as one factor enhancing the transfer process as well as the organizational climate for change. With elevator installation simulation there is clear organizational climate for change, since the simulation is especially built to practice elevator installation and meant to be implemented to the training program. Peer support is also provided by the KONE facilitator facilitating the training sessions and by colleagues and fellow students also practicing in the simulation. Based on the transfer models mentioned above, peer support and organizational climate for change affect trainees’ personal ability to transfer. Ability to affect other parts of transfer process than just the training design is

remarkable benefit. Conditions for transfer of training are favorable also because of the training design is based on the exact same 3D models that are used to produce real MonoSpace® 500 elevators, and according to Oxford References¹⁹ the transfer tends to be positive when task practiced contains same kind of responses in the training than in the real world. Responses in the simulation are almost identical to the real-world work progress, because the elevator components are installed in the same order in the simulation, but the simulation does not require the user to for example to tighten up every single screw – only one per component is required and then audio guide tells he does the rest.

Since the virtual reality training was described by the interviewees and survey respondents as a positive learning experience, and based on previous research literature, several important factors required for efficient transfer of training to happen are fulfilled – practicing elevator installation in virtual reality simulation could indeed enhance the transfer of training. To verify this result, a longer follow up study with control group would be required. This might be possible to conduct in the future when the gamification pilot is implemented more widely in KONE. It would have been an ideal scenario to conduct follow up study right from the beginning, but since this is just a master's thesis and the time was limited, the possibilities and attitudes of the whole training method were mapped first with this study. With this study it can be now confirmed that the follow up phase of the implementation is needed. Future research case could be for example setting up a control group that does not receive any virtual reality training through their installer learning path, and compare their first-year results to the other group that got to practice installation modules in virtual reality. FYCOR could be utilized in this with other measuring tools. These results could be then supplemented with interviews, maybe both in the training phase and in the end of the first work year. This way it could be possible to see the concrete effects of the virtual reality training to the transfer of training.

It turned out that the questions asked in the survey and interviews didn't best answer to the question how virtual reality training affects the learning experience, since the answers had to be drawn from variety of discussions and replies. Maybe some other measuring tool than what was used here, would have provided more detailed answers. With the methods and questions used here, a good enough perception of the effect was received, but more justified explanations from respondents and interviewees about *why* the learning experience was positive or pleasant, could have been remarkable. I still feel that research question set in the beginning of the process was answered and argued in this

¹⁹ Transfer of training. Oxford reference database.

<http://www.oxfordreference.com/helios.uta.fi/view/10.1093/acref/9780199657681.001.0001/acref-9780199657681-e8526> Accessed 28.10.2917.

thesis, especially because the purpose of the study was not only to get one master's thesis done, but to inspect the possibilities of the transfer of training to happen, VR training's benefits to KONE and if the VR simulation is worth of implementing more widely in KONE in addition to these piloting areas researched here. Based on the results we got from the pilot, the wider implementation and making new installation modules has already started.

I am personally really satisfied with this study even though this might not have been the most ideal way to research this phenomenon. In KONE I had good resources to study the virtual reality learning, and great access to proper sample of survey respondents and interviewees to make the best out of the research topic. Virtual reality in different usages has been the main theme of my studies – my bachelor's thesis was about haptic feedback in VR. It was truly worth of conducting hands on case study with real context about the topic, because even though I of course expected and hoped that the VR training has an effect on transfer of training, I couldn't have imagined how elevator installers perceived virtual reality and how liked form of training it can be.

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ATTACHMENTS

Attachment 1: KONE Mission, vision & strategy. KONE intranet, 2017.

- Provided if needed.

Attachment 2: Blended learning at KONE, Analyzing the situation, Target group.

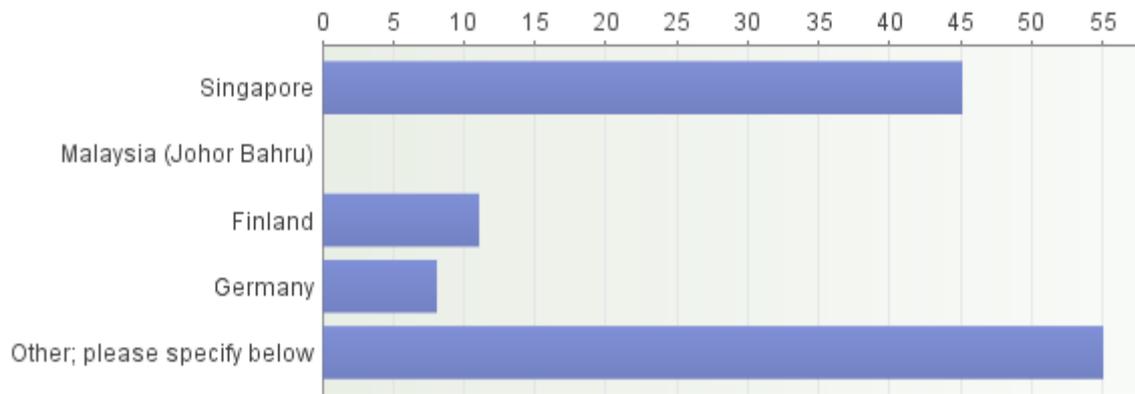


Attachment 3: Survey questions and answers

VR MonoSpace 500 Installation - PILOT

1. Where did you use the VR simulation?

Number of respondents: 119



2. Location of VR system, if other (above)

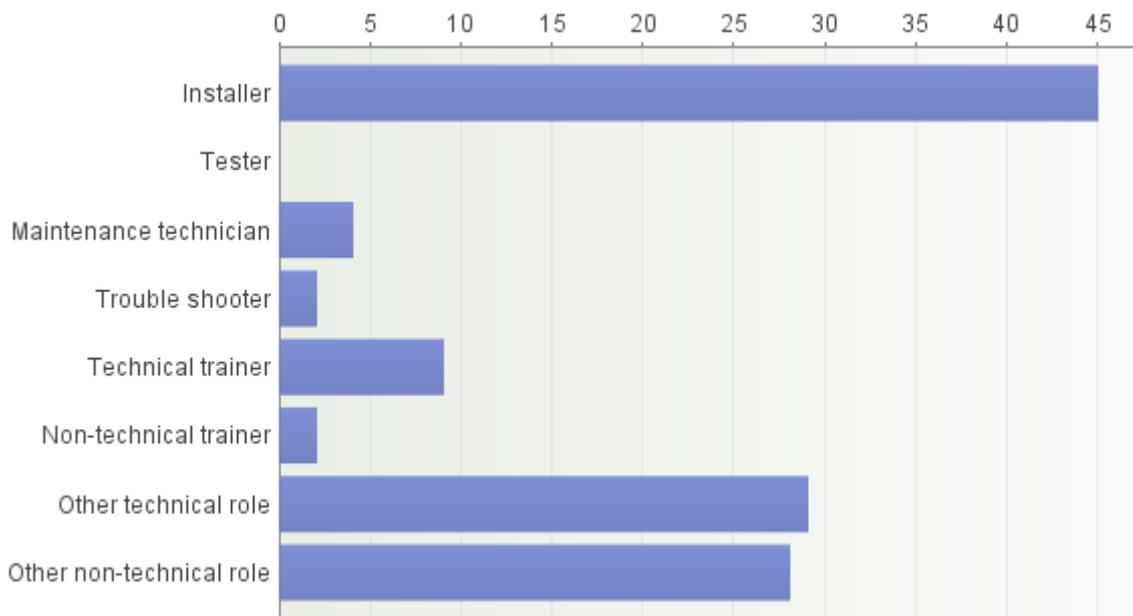
Number of respondents: 59

- Training room
- Singapore
- Singapore
- Training room
- KONE Academy Hannover
- Philippines
- Philippines
- Philippines
- Philippines
- Phikippines
- Philippines
- Philippines
- Philippines
- Philippines
- Philippines
- Philippines

- Norway
- Norway
- Oslo norway
- Norway
- Norway
Norway
- norway
- norge
- Norway
- Norway
- Norway
- oslo norway

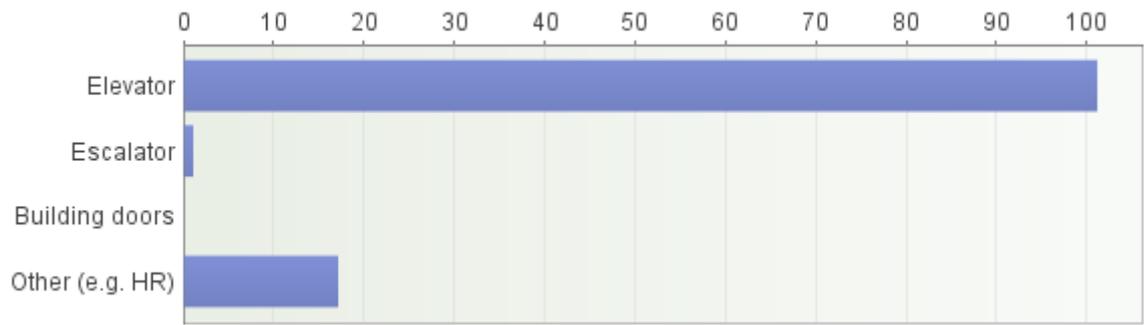
3. What is your primary work role?

Number of respondents: 119



4. What is your primary competence area?

Number of respondents: 119



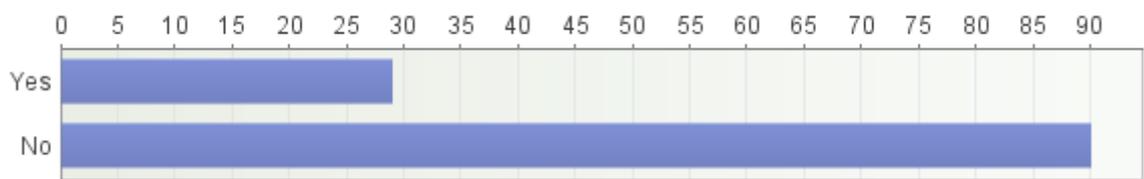
5. How long is your work experience in your role?

Number of respondents: 119



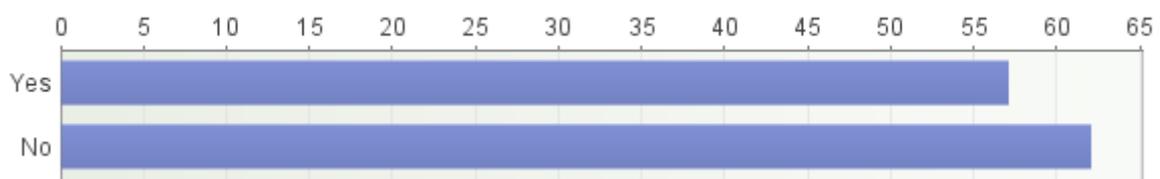
6. Have you tried any virtual reality simulation before?

Number of respondents: 119



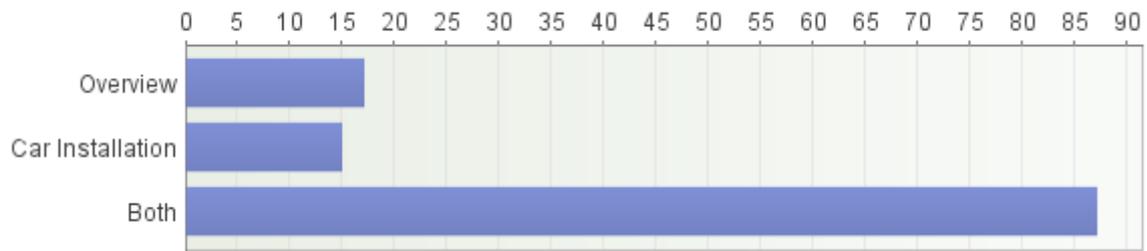
7. Do you play digital games in your free time?

Number of respondents: 119



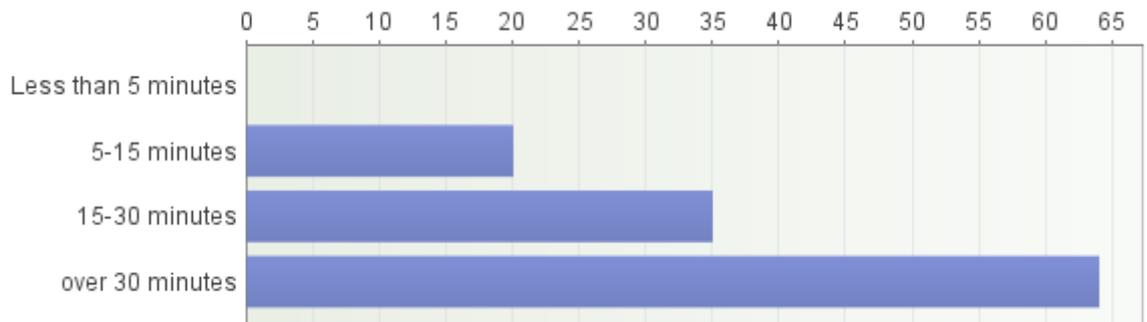
8. Which VR MonoSpace 500 installation modules did you play?

Number of respondents: 119



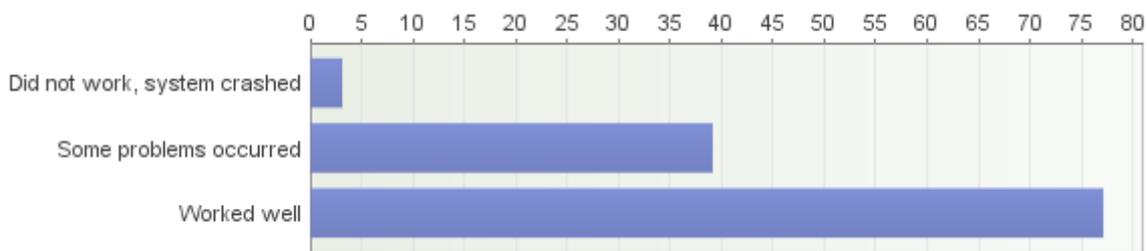
9. How long did you play the game? (minutes)

Number of respondents: 119



10. Did the VR simulation system work smoothly?

Number of respondents: 119



11. VR environment: how well do you agree with the following statements?

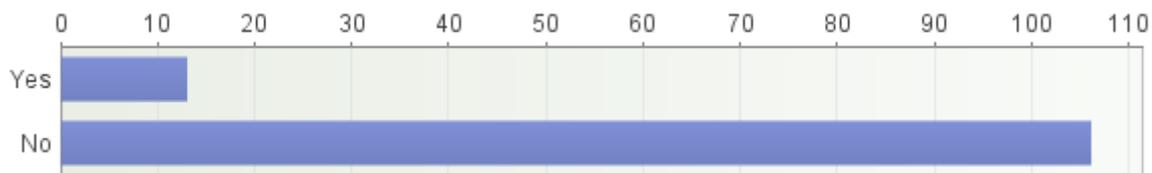
Number of respondents: 119

	1	2	3	4	5	Total	Average
VR environment is easy to navigate	0	2	9	59	49	119	4.3

VR model with elevator and building is good	0	0	5	49	65	119	4.5
Hand controls and functions are easy to use	0	2	13	48	56	119	4.33
Total	0	4	27	156	170	357	4.38

12. Did you encounter virtual reality sickness (nausea, dizziness etc.)?

Number of respondents: 119



13. Description of “Yes” answer: what kind of symptoms did you have?

Number of respondents: 12

- If I move too fast, I feel the dizziness.
- Something is new
- Dizziness
- I have glasses. After I have finished my job, I had a problem with my spatial view.
- None
- Dizzy little
- Feel a little dizzy
- Colours too bright, nausea
- Dizziness when the surrounding moved, I almost fell on the floor
- vähän huimausta kun lopetti
- Some nausea when sitting on the car roof in the end of the session

- Little nausea

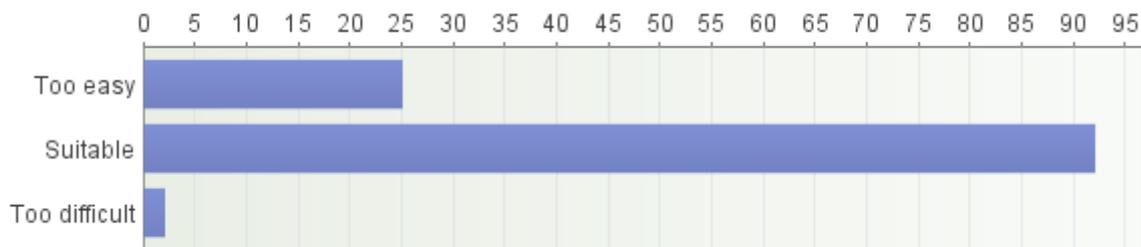
14. How well do you agree with the following statements?

Number of respondents: 119

	1	2	3	4	5	Total	Average
Instructions were good and informative	0	3	9	49	58	119	4.36
General structure is good and support learning	0	0	5	51	63	119	4.49
Separate tasks are good and support learning	0	1	5	57	56	119	4.41
Simulation could be used as a part of installer training	0	0	4	33	82	119	4.66
Things learned in simulation could be useful in real life work	0	2	5	48	64	119	4.46
Total	0	6	28	238	323	595	4.48

15. Learning tasks difficulty level

Number of respondents: 119



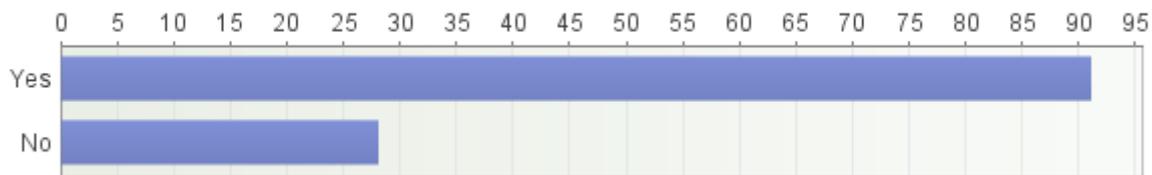
16. What was your overall impression?

Number of respondents: 119

	1	2	3	4	5	Total	Average
My overall impression	0	0	6	43	70	119	4.54

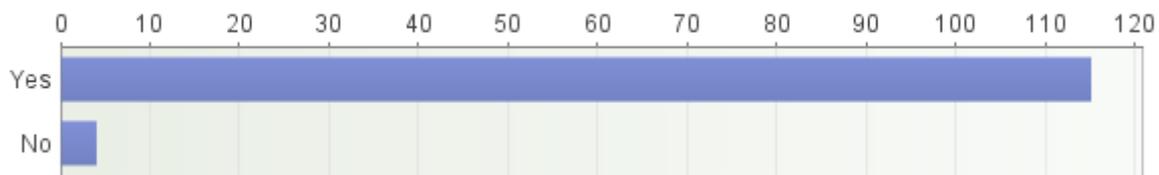
17. Did you learn anything new that you haven't learned with other learning methods?

Number of respondents: 119



18. Would you recommend this game to your colleague?

Number of respondents: 119



19. General feedback

Number of respondents: 65

- Very good way to train installer in a safe environment. All steps and components can be demonstrated and physically tried out, repeatedly until full understanding is achieved
- Add reference to QD checks and explain to fitters why building the car sling is important to ride comfort and FYCOR.
- Experience was great
- Good training
- Very experience and easy to but ci have confussing inm controlling button
- - use text overlay to guide and complement spoken instructions
- - clipping, objects shouldn't be able to go through one another
- - add incentive elements for speed, quality, safety
- Now, I am clear on which items are being installed first..

- It will be good if can move the lift car cage up and down during the overview so that can have a good view on machine and doors.

Wired VR equipment may cause tripping while move around.

Apart from that the rest were excellent

- Lift installation simple and good
- Very excellent learning.
- It could be good to avoid object penetration, to be able to control the cop when installation is finished, to have a system with some feedback when touching objects. Installation of turnstiles, dop and kone access would be nice to have.
- Its good for learners. Simple to learn in easy method
- Overall good learning system for us .
- Lean
R
- Like it
- More app like for escalator maintenance method as well maintenance troubleshooting
- Safett related topics especially around fall protection would be good to include
- Will be good to have instructions and prompters earlier. Currently it is a bit of lag. Will be good to have prompters like "teleport yourself there". External guide (person) are very helpful! Very cool stuff indedd!
- Awesome experience. Great learning tool and effective especially for non-installers so they have a good understanding of lift installation. E.g. sales people.

Points to note:

1. How to cover a large group of people that needs to be trained?
2. Incorporate safety awareness like picking up heavy equipment, releasing hoist control, etc.

- Is really awesome to experience VR
- Very innovative way of learning
- Very impressive
- Excellent Experience Can be oriented to customer
- Das Trainingsprogramm hat mit sehr gut gefallen (I liked this training programme.)
- bring it in more details and than its very great!!!
- Zu Fage 17 : mit vorwissen hab ich keine neue erkentnisse erzielt, aber ansonsten ist es gut gemacht. (Concerning question 17: Due to preknowledge I have not learned anything new, but the training was well-structured)

Generell : (generally)

Die Erfahrung hat mich Positiv überrascht und würde mich freuen wenn es weiterhin

ausgebaut wird und mehr auf feingefühl geachtet wird (This experience has surprised me in a positive way and I would be happy if this technique was expanded. In the future it is also important to pay even more attention to sensitiveness.)

Ich bin Auszubildener im 3.Jahr (Trainee) (I am an apprentice in the third year of my apprenticeship.)

- Auszubildener 3.Jahr (Trainee) (I am an apprentice in the third year of my apprenticeship.)
Montagetraining im Vorraus absolviert, daher keine neuen Informationen. Lerninhalte werden gut und einfach vermittelt. Die Steuerung ist teilweise etwas umständlich.
(Installation training was completed before, therefore I have not gained new knowledge. Learning content was fine and was taught in a simple way. Navigation is partly inconvenient.)
- Azubi Montagetraining zuvor absolviert (installation training for apprentices was completed before)
Mir hat dieser einblick sehr gut gefallen. (I liked to get an insight.)
Ich kann dieses „Traning“ nur empfehlen. (I can recommend this „training“.)
- Genial (ingenious)
- really good please carry on ;-)
- To localize the product, introduction to products in the beginning, felt that was falling
- Would be nice if you have the local language
- Look for tirak during 80 % of installation should be there
- Its nice i know the correct method.
- Its good to play but sometimes its hard to use the gudget
- Thanks for the vr experience
- It was good and very informative.
- Awesome training tool!
- it was fun, but some difficulties i experience while using VR
- Good teaching more training
- Its good for the new comers to know the components first and start this learning.
Over all its good and will recommend for training purpose.
- I hope there is also virtual game for escalator
- Just the height issue. Should be suitable to asian height
- The virtual installation of elevator is very nice and i want to be finish all the installation from plumb to testing commissioning. I hope that escalator virtual installation is available also to be more familiar to the installer
- That was great experience
- Very good simulator system
- It's awesome

- The game was so informative. Just some technical difficulties, but overall it is fun.
- The VR was really good and that users will really learn the intallation methodology even before they go to the actual site
- Headset had a glitch when reaching a wall then everything is greyed out. But overall it was fun
- A fun way to learn
- It's very good and will be helpful for on boarding installation personnel
- Its a good training for the intallers.
- Very innovative and easy to learn
- VR Training, Field Training, Class-room Training are all vital to increase competency level and training absorption
- Very good learning experience. Would recommend to use as part of training new (and why not old) installers.
- vision got blurry few times but i dont know if its was my eyes or meaby headset wasnt propelry on my head all the time. i think learning elevator installation gets better when u get used to the system and dont have to think some much how it works all the time. headset got very sweaty during car istallation.
- It was better than I expected.
- Fun to try, hope there will ve made a version for the doors installation.
- It was a fun way of learning and for me who never have been in a shaft before, it was informative.
- Great session, this is forward thinking at it best! Hope to see this as a part of training in the future.
- Perfect to learn the new method for those that have not been teached. And a perfect way to use on practikants to give them a quick course to see how an elevator is built. And it could be used to promote the profession of elevatoinstaller to students etc.
- Good tool to the beginners but the fitters already know all of this
- Very good way to show new colleague/apprentice how elevatoinstallation works and to learn new installation methods
- Instructions went a bit fast on car installation.
impressive VR!

Attachment 4: Interview structure

HAASTATTELUKYSYMYKSET

Henkilöhaastattelut:

Taustatiedot

- Sukupuoli: mies/nainen/muu (Gender: man/woman/other)
- Ikä (age)
- Toimenkuva/rooli (role)
- Oletko aikaisemmin testannut virtuaalitodellisuutta? (Have you tested virtual reality ever before)
 - Mitä, missä, milloin, kuinka kauan? (What, where, when, for how long)
 - Kuvaile kokemusta (Describe the experience)
- Pelaatko digitaalisia pelejä vapaa-ajallasi? (Do you play digital games in your free time?)
- Miten opit parhaiten? (How do you learn the best?)
 - Kuvaile (Describe)
 - Kuuntelemalla, kirjoittamalla muistiinpanoja, tekemällä, katsomalla jne. (By listening, writing notes, doing, looking etc)
 - Kerro jokin mieleesi painunut erityisen onnistunut oppimiskokemus. (Describe some especially successful learning experience.)

Simulaatio

- Koitko pahoinvointia simulaation aikana? Kuvaile. (Did you feel some nausea during the simulation. Describe)
- Vastasiko simulaation asennustilanne mielestäsi todellisuutta? (Did the installation situation of the simulation correspond with reality?)
 - Miksi, miksi ei? (Why, why not)
- Minkälaiseksi oppimiskokemukseksi kuvailisit tilannetta? (What kind of learning experience would you describe the situation?)
- Saiko ohjaimilla mielestäsi realistisen tuntuman simulaatioon? (Did you get realistic feeling of the simulation with the hand controllers?)
- Puuttuuko simulaation asennustilanteesta mielestäsi jotain olennaista oikean asennustilanteen kannalta? (Was there something crucial missing from the simulation when thinking about the real installation situation?)
- Oliko kokemus mielestäsi miellyttävä? (Was the experience pleasant?)
- Pelaisitko uudestaan? (Would you play again?)

Potentiaali

- Sopiiko simulaatio mielestäsi uusien asentajien koulutukseen? (Is the simulation suitable for new installer training?)
 - Miksi, miksi ei? (Why, why not?)
 - Mihin vaiheeseen koulutusta sijoittaisit simulaation käytön? (In which part of the training program you would recommend the simulation?)
 - Kuinka monta simulaatioharjoituskertaa olisi hyvä? (How many simulation sessions is needed?)
- Mikä on suhtautumisesi digitalisaatioon, digioppimiseen ja pelillistämiseen? (What do you think about digitalization, digital learning and gamification?)
- Uskotko, että simulaatiossa harjoittelulla on vaikutusta oppimisen siirtovaikutukseen (työelämä) verrattuna tavallisiin oppimismenetelmiin (luokkaopetus + oikean hissi)? (Do you think that practicing in the simulation has an effect to the transfer of training effect to the real working life?)
- Mitä esteitä, haittoja ja mahdollisuuksia näet simulaatiossa? (What obstacles, disadvantages or possibilities do you see in the simulation?)
- Kenelle suosittelisit simulaatiota? Rooli/ammattiryhmä? (To whom would you recommend the simulation? Role)
- Yksin vai yhdessä? (Alone or together?)

Onko mielessäsi vielä jotain, mistä emme keskustelleet? (Is there still something that we didn't discuss?)