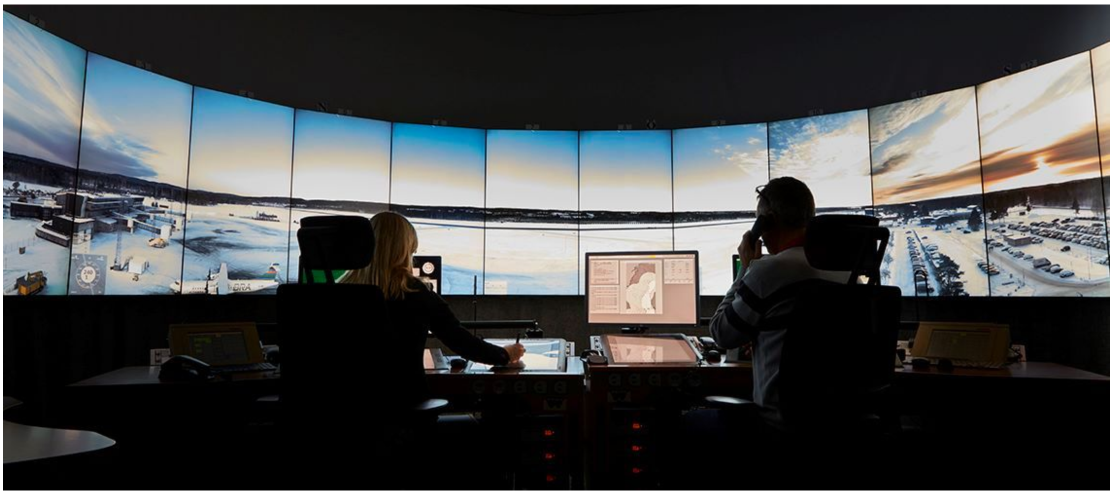
UNIVERSITY OF GOTHENBURG

DEPARTMENT OF APPLIED IT

Simulation Meets Reality

The Remote Tower System as an Air Traffic Control Training-Environment



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Abstract

The remote tower system provides a new way of controlling traffic at an airport, and it might change the way air traffic controllers are trained as well. The purpose of this study was to explore the remote tower system as an air traffic control training-environment. Investigating new functional possibilities, such as moving the simulator into the workplace, and implications for the practical implementation of the system for training.

There has been very little investigated about the remote tower system as a training-environment, which means that this study is breaking new ground. To explore this new setting, theoretical aspects relevant to the remote tower has been identified from literature in related areas, a survey was held among air traffic control trainees, and interviews were held with a heterogenous group of experts.

Based on the results there are clear implications for the potential of the remote tower system as a training-environment. Moving the simulation into the workplace improves fidelity and facilitates transfer, functional aspects could positively contribute to the training by increasing situational awareness and reducing cognitive load, and by implementing the remote tower in a centre setting the training can be shortened due to a greater similarity between workingpositions and equipment.

The implications need to be investigated further to get a more concrete idea of the implied positive effects and how the remote tower system as a training-environment can be used in the most efficient way.

Keywords: *Air traffic control, remote tower, training, simulation, fidelity*

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1 Introduction

The field of air traffic control is an area of continuous development and improvement. Demands such as rising traffic volumes, improved safety and higher cost-efficiency are reasons for constantly seeking new and better ways to manage the traffic flow. In the last years the implementation of remote tower systems has created new possibilities for controlling traffic at an airport. Traditionally the air traffic controller is situated in a control tower at the airport and has a direct visual view of the airport and surroundings. In a remote tower system (RTS) the tower is being replaced with high definition cameras that allows the controller to work from a centralized location which might be many miles away.

The first operational remote tower system was the system from SAAB being used in Sundsvall (Sweden), which went 'live' in 2015. This study will use the SAAB remote tower system as reference.

Except the technological possibilities for providing air traffic control (ATC), the remote tower system might also provide new opportunities for ATC-training. Traditionally ATC-training is done in simulators and at the real workplace. A remote tower system makes it possible to move the simulation into the workplace where the remote tower system can be seen as an integrated system where the simulation is taking place in the actual working-environment. This concept is illustrated in Figure 1.

A challenge that goes back a long time within the industry, is to find enough air traffic controllers (Oprins, Burggraaff & van Weerdenburg 2006, Schneider 1985, among others). Many trainees do not meet the required standard within the available time-frame which leads to a lot of effort and resources lost in training. Against this background there is an obvious need to improve training efficiency and effectiveness whenever possible. The new technological possibilities, such as integrated simulation, could have implications for future ATC-training and could contribute to the improvement of the training.

There has been little published on the use of remote tower systems in ATC. In the specific area of education and training within this system no such previous research has been found in the preliminary phase of this study. Previous research has focused mainly on different specific parts of, or tactics within, ATC-training: General training versus specific (Siegel, Richlin & Federman 1960), Simulator training (Schneider 1985), Cognitive load and task selection (Camp 2001, Salden, Paas & van Merriënboer 2006), Competence-based assessment (Oprins et al. 2006), Instructor and trainee interaction (Koskela & Palukka 2011, Arminen, Koskela & Palukka 2012), just to mention a few.

What makes the remote tower setting unique is how some of these different elements could come together. Looking at the RTS as an integrated system could create new possibilities for studying air traffic control training. The perspective of workplace learning and the application of simulation in the work environment are examples of two of these new possibilities.

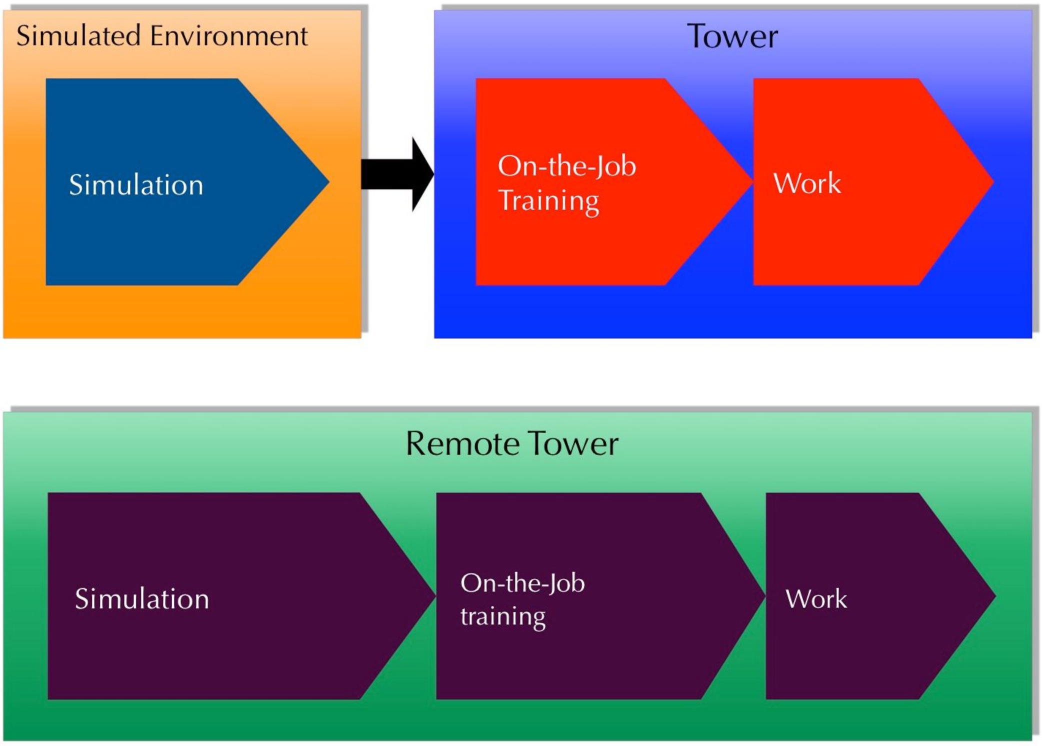

Figure 1. The concept of the remote tower system as an integrated system with simulation capability, compared to a more traditional approach. The top graphic shows the current situation where the simulation is separated from the workplace. At the bottom the remote tower system as an all-in-one concept.

Making the distinction between training in the simulator and on-the-job (OJT) training as different training-experiences, Koskela & Palukka (2011: 311) describes the need to study how simulator and on-the-job training can be better integrated:

> *"Greater attention should be given to the ways in which these two types of training experiences and activities are appropriately reconciled. Consequently, further research is needed to see how these two separate areas of learning can be more effectively integrated."*

Investigating the remote tower setting could be a step to bring the simulator and workplace together. Relating to the contextual and functional possibilities of the remote tower system, moving the simulation into the workplace. To what extend the remote tower technology could contribute to the field of ATC-training is something that needs to be explored further and this study aims to make a start at fulfilling this need.

1.1 Purpose and research questions

The overall purpose of this study is to explore the remote tower system as an ATC training-environment. More specifically, the study will focus on the new possibilities of the remote tower system as an integrated system, how this system might change the training experience compared to the more traditional set-up (with a simulator next to on-the-job training), and what implications for future training can be identified. The study will examine the following questions:

- How could moving the simulation into the workplace change ATC-training?
- How could the new functionalities of the remote tower system affect training compared to current practices?
- What implications for future ATC-training can be identified when using the remote tower system?

Due to the exploratory nature of the study, practical considerations that might play a part in a real life implementation of the system will not be taken into account when investigating the research questions. This means that practical factors such as costs and rostering of personnel will not be taken into consideration.

The report starts with a presentation of the remote tower system to give an idea of what the remote tower system is and the relevant functionalities. This is followed by a section on related work, which forms the theoretical context of the study. Thereafter the method, results, discussion and future research is presented, ending with the conclusions.

2 The Remote Tower System

For the purpose of this study the remote tower system will be defined as an air traffic control tower workplace with an integrated simulator possibility and added functionality. The main (and most obvious) difference to a regular ATC-tower is that the outside view has been replaced with a number of screens where a live-video of the airport and surroundings is presented. This means that one working position could potentially be used for different airports or be used as a training-environment with a simulated outside view. Figure 2 gives an idea of what a remote tower working-position can look like.

Using video and camera technology the outside view can be improved and extra information can be added. Working with overlaid information means that the controller can see relevant information directly on the screen producing a form of augmented reality. This can reduce head-down time as the controller has all information in sight, and as Papenfuss et al. (2010) indicate, this also might have a positive effect on situational awareness and controller workload.

The remote tower technology also makes it possible to bundle the ATC-operations of many airports at the same location. Sharing resources and infrastructure creates opportunities to reduce costs and improve staff efficiency, which can be especially important in the case of smaller airports where ATC-costs may be a large portion of the total costs (SAAB 2017).

Figure 2. Remote tower system from SAAB Digital Air Traffic Solutions, Sweden (SAAB 2018).

There are several added functions available in the remote tower system compared to a traditional tower. These functions aim to improve the situational awareness of the controller and in the extension improve the safety and traffic capacity. The following global functions, distinguished by Schaik et al. (2010), are still relevant even though the study is a few years old and written when the system was still in the prototype-phase:

- **Overlaid geographic information,** runway and taxiway contours and other relevant parts of the aerodrome can be accentuated. This helps the situational awareness especially in low visibility conditions.
- **Visual Enhancement Technology,** technology where the camera view is artificially improved for example through the use of infrared technology or filtering of the imagedata.
- **Meteorological and airport information,** information such as wind and runway visual range can be presented on the screen which reduces head-down time.
- **Sensor-data fusion,** combining camera and radar data, the system can detect and indicate aircrafts, vehicles and animals on and around the aerodrome.
- **Aircraft and vehicles,** using sensor- and camera-data aircrafts and vehicles can be tracked on the screen and presented with a label showing relevant information such as callsign and altitude.
- **Pan-Tilt-Zoom camera,** this camera can be used as the old binoculars. It gives the possibility to zoom in a part of the aerodrome or an aircraft. It can also track a moving object for example to check for landing-gear problems of an landing aircraft.

Figure 3 below illustrates one of the ways that this added information can be included in the outside-view of a remote tower system. The picture is from London City Airport where they are currently in the last stages of implementation of the SAAB remote tower system. Figure 4 to 7 also show the use of added functionality in the form of:

- overlaid geographic information, contours of taxi and runway (Figure 4)
- overlaid meteorological data, wind data (Figure 5)
- object tracking, a helicopter approaching the airport (Figure 6)
- the use of the zoom camera, helicopter parked at the platform (Figure 7).

These are functions unique to the remote tower system and not available in a traditional control tower.

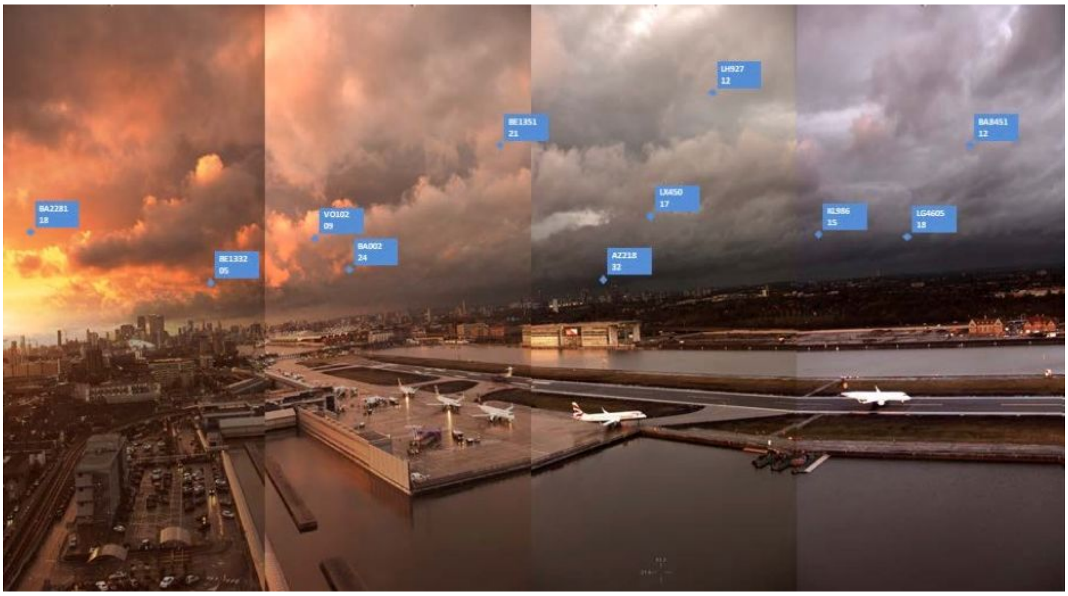

Figure 3. Remote Tower view from London City airport. Tracking labels of aircraft around the airfield meant to increase situational awareness (SAAB 2018).

The above mentioned functions primarily have an operational use and are based on operational requirements. The main aim is to increase safety and/or efficiency. From the perspective of a training-environment, other aspects and uses of these functions might be identified. This also includes functions directly related to technical aspects and characteristics of the system, such as using screens for the outside view. For example, working with screens makes it possible to use the workplace for simulation-training, moving the simulation into the workplace (as described in the introduction and Figure 1). How these new functions, included in the remote tower system, can be used in ATC-training is one of the aims of this study.

Figure 4. Overlaid geographic information in Sundsvall, Sweden (SAAB 2018).

Figure 5. Overlaid meteorological information (SAAB 2018).

Figure 6. Tracking of a helicopter during the remote tower tests at Groningen Airport in september 2016 (image provided by LVNL).

Figure 7. The Pan-Tilt-Zoom camera makes it possible to have a closer look, much like the traditional binoculars used in a control-tower (image provided by LVNL).

3 Related work

In the previous section, the remote tower system and its basic functionality was presented. This section will treat relevant theory and describes a theoretical context for the remote tower system as a training-environment.

The remote tower system is part of recent technological developments within air traffic control. Due to the minimal amount of previous research within the specific field of remote tower training, this study will take a broad approach and also look at research from other areas of aviation and maritime training when relevant for the question at hand. Some more general training-theory will also be included to provide a more general base.

One way to get an overview of the research field is to use a concept-map (Maxwell 2013). Figure 8 has been inspired by that idea and illustrates the theoretical aspects of the remote tower system as a training environment as well as factors related to implementation. The categories have been identified from related literature. The different categories in the model depicted in Figure 8 will be discussed further in this section below, starting with workplace learning, then discussing simulation and transfer, functions and cognitive aspects, and regulation. As may be noted, this does not entirely follow the categorisation from the model. The reason for this is that some of the parts can better be presented together as they have a relation to each other. For example, the functional aspects of the remote tower system have a direct influence on the cognitive aspects,and are therefore discussed together in 3.3.

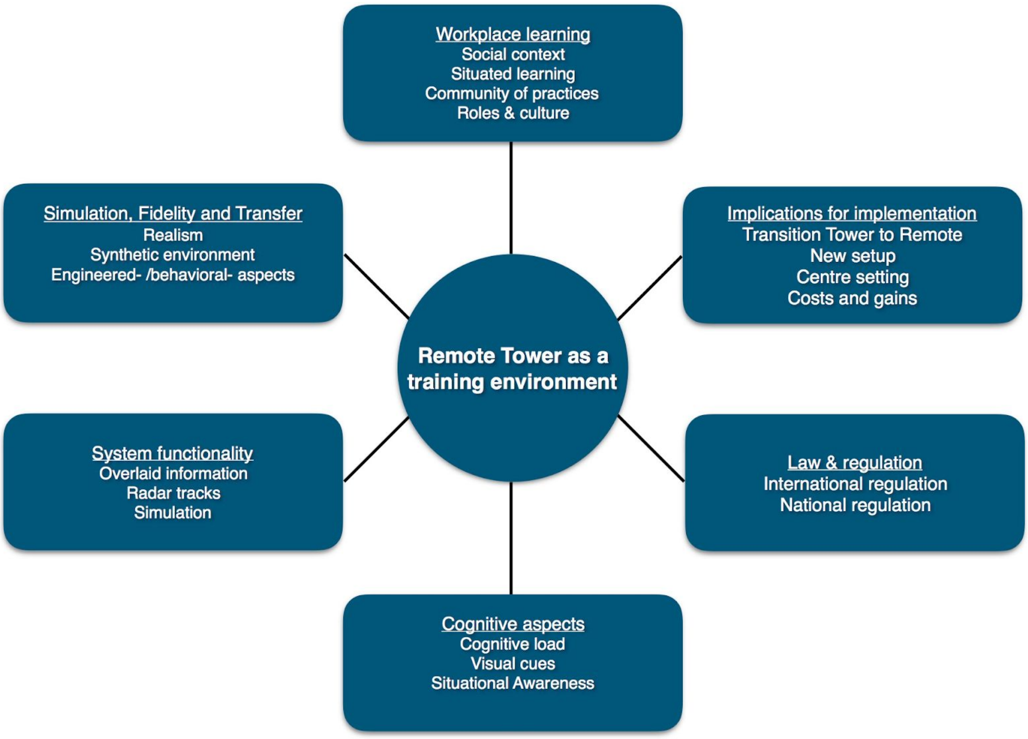

Figure 8. Concept-map of different aspects of the remote tower system as a learning environment. The different categories are based on identified aspects from related literature as described in this section.

3.1 Workplace learning

Air traffic control has traditionally been viewed as a complex cognitive or a high-performance skill, where the focus lies on the individual cognitive task of knowledge and skill acquisition (for example Schneider 1985, Salden et al. 2006, Oprins et al. 2006). Salden et al. (2006: 351) even mentions how individual training is to prefer in comparison to group-training when it comes to complex cognitive skills. This points to how the cognitive perspective is well rooted in the area of ATC-training.

In recent years there has been an emerging tendency in research to focus on the social and cultural aspects as well, shifting focus away from the cognitive perspective. For example Koskela & Palukka (2011) and Arminen et al. (2012) makes a point of stressing the need of a broader approach, including the situated aspects of ATC-training. Also outside the area of Air Traffic Control this can be seen. For example in the work of Sellberg (2018) in the area of maritime training, where the interaction between the instructor and the trainee in ship-bridge training is studied.

ATC- training in general, but especially on-the-job training, can be seen from the perspective of workplace learning. The training takes place within a social context where the trainee has to learn how to perform the complex task of air traffic control under the informed guidance of a qualified instructor (i.e. an experienced controller) but also in cooperation with colleagues and other involved parties (Koskela & Palukka 2011).

Gherardi et al. (1998: 277) write the following about the situated nature of learning:

> *" When applied to the workplace, this social perspective portrays on-the-job learning as an ongoing social activity aimed at discovering what is to be done, when and how to do it according to specific routines and using specific artefacts, and how to give a reasonable account of why it is done and of what sort of person one must become in order to be a competent member of that community."*

Gherardi's view of situated learning in the workplace leans on the work of Lave & Wenger (1991) and their description of learning as a social and cultural activity where the newcomer starts in the periphery of a community and successively learns the practices of that community to finally become a full grown member. From the perspective of situated learning the learning itself occurs through participation in the activities of the community, where the focus lies on knowing as opposed to knowledge (Säljö 2015: 117).

Workplace learning can also be studied from the perspective of roles and interaction between different actors. For example Sellberg (2018), Arminen et al. (2011) and Koskela & Palukka (2012) study the interaction between trainee and instructor in simulation-training and on-the-job. The importance of this interaction is also a point also made by Rystedt & Sjöblom (2012) discussing how simulator fidelity is not the only (or even most important) factor for successful training. Simulation and fidelity will be discussed further in the next section.

3.2 Simulation, fidelity and transfer

Simulation has been used in the field of aviation for a long time. Initially a matter of safety (it is quite obvious that the consequence of an error can literary be fatal in flight training) it now encompasses many areas, for example Crew Resource Management, basic Stick-and-Rudder Skills, Instrument training and decision making (Salas, Bowers & Rhodenizer 1998).

In Air Traffic Control training, simulators has a long history as well. From initially using models and aircraft that had to be moved by hand to the advanced high fidelity simulators used today. One of the main aspects with simulation training is how the skills learned in the simulator transfers to the real work-environment. One example of early research in this domain is the research done by Siegel et al. (1960) about how different training approaches translates to practical knowledge. Siegel et al. (1960) makes a comparison between a more general approach and a specific approach to training and how this affects transfer.

Schneider (1985) makes the point that the simulator gives more possibilities in training than just replicating reality. The simulator can be used to build routine with events and actions that normally don't occur that often, or you could speed up and repeat events to promote automatisation. This principle is also supported by the more recent findings of Donderi et al. (2012) who investigated the positive influence of Above Real Time Training (ARTT) on transfer of training.

Figure 9 below serves to illustrate the more practical side of training on an airport with a high degree of variating traffic volumes. As shown there might be only a few traffic-movements during the day (blue bars in the Figure), which means that the opportunity to train specific events could be very few or non-existent that day. The great variance in traffic also mean that it could be hard to plan training, and that a novice trainee might be overloaded on a busy day. One way to manage this problem is to use simulators.

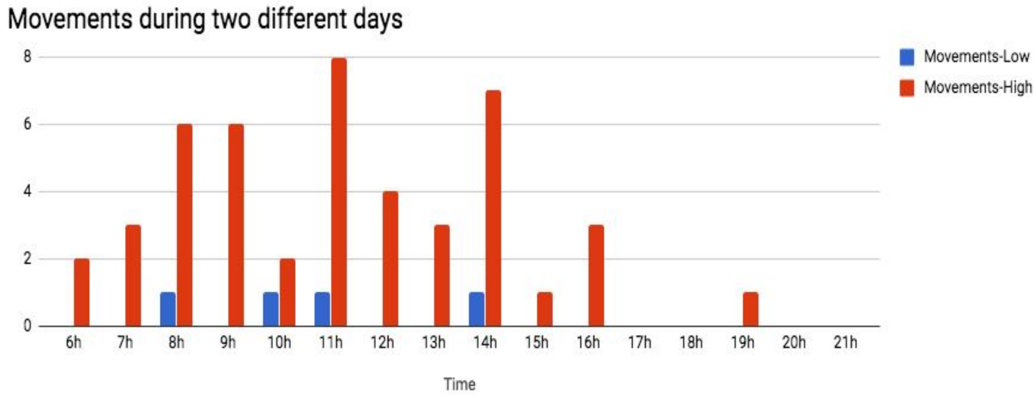

Figure 9. Actual traffic count from Groningen Airport on march 30th (red) and april 1st (blue) 2017. The bars represents the number of movements each hour and shows the difference between a day with low and high traffic volume (data from LVNL).

When discussing realism and simulation, the concept of simulator-fidelity is often used. Fidelity is a multi-dimensional concept and relates to the realism or authenticity of the simulator and the simulation. It encompasses the physical and engineered aspects as well as the psychological and behavioral aspects of the simulator. The concept of fidelity can also be somewhat problematic. It can relate to almost every conceivable aspect of the synthetic environment and can include such diverse aspects as audio, the feel of buttons, visual effects or the behavior of aircraft, to mention a few (Hamstra et al. 2014: 387-388). From a training design perspective the fidelity can be viewed as structural, which relates to the physical properties and the handling characteristics, or functional, which relates to the scenarios and setting (Hamstra et al. 2014).

Research on different aspects of simulator fidelity and their effects on transfer of training is non conclusive. For example Norman, Dore & Grierson (2012) conclude that there is just a minor gain from using higher fidelity simulation and Rystedt & Sjöblom (2012), studying simulation-training in healthcare, argue that the realism of the simulator is not in itself responsible for good training but that it is a combination of simulation, instruction and context. This can be seen against the background of the traditional notion that more realism is always better. In general terms this boils down to the idea that you get good at what you practice. Scientifically the idea that higher realism is always better traces back to Thorndike & Woodworth’s (1901) early work on the training of mental functions, where they conclude that:

> *“ The mind is [...] on its dynamic side a machine for making particular reactions to particular situations. It works in great detail, adapting itself to the special data of which it has had experience.”* (Thorndike & Woodworth 1901: 249-250)

Hamstra et al. (2014) nuance this by arguing that the focus should be on functional fidelity and the match between that what should be learnt and the applied context. The more recent research in this area often takes a flexible stand on fidelity (i.e. Rystedt & Sjöblom 2012, Sellberg 2018, Hamstra et al. 2014, Norman et al. 2012). A full fidelity simulator may not be the highest goal in itself, and not always the best tool for learning a specific task. Depending on what is to be learnt different aspects of the simulation need to be more or less real, and are more or less important for the training. Arguments for this vary, but the high cost and accessibility of high fidelity simulators and the possible cognitive overload created by a too complex simulator, are two examples.

3.3 Cognitive aspects and system functionality

Air traffic control can be seen as a complex cognitive task. Much of the previous research on ATC-training takes this perspective, studying different cognitive aspects of learning and the influence of cognitive functions on the effects on learning. For example Salden et al. (2006) and Camp et al. (2001) studies how training can be improved by an adaptive curriculum where the learning task is selected based on mental effort and cognitive load.

Papenfuss et al. (2010) studied the effects of different remote tower functions in a simulated setting. Although there are no statistically significant results, there is an indication that using tracking labels can reduce controller workload. This might partly be explained by the notion that the task of the air traffic controller is to interpret complex visualizations (van Meeuwen 2013: 19), and that presenting information directly on the outside view screen reduces the visual complexity.

In the remote tower system there are several functions designed to reduce head-down time and to increase situational awareness. For example the augmented information and tracking labels. From a cognitive load perspective, this relates to the split-attention effect as described by Sweller, Ayres & Kalyuga (2011). Information of different kind and/or from different sources can increase the demand on working memory due to the need to remember the information while switching attention between different related bits and pieces and putting it all together (Sweller et al. 2011: 111).

The relation between cognitive load and learning can further be seen from the perspective of cognitive load theory. This theory, initially put forward by Sweller in the mid 80s, makes a connection between working memory limitation and learning. Information that has to be processed takes up space in the working memory, and if the working memory is overloaded this disabilitates learning (Sweller et al. 2011). The experienced cognitive load is individual and dependent of previous experience, knowledge and the overall task complexity. The notion that a high fidelity simulator might be too complex (as mentioned in the previous section) is based on the principles of cognitive load theory.

Although cognitive load theory explains some basic principle of learning in complex cognitive environments there are some critics as well. Schnotz & Kürschner (2007) remark that cognitive load theory does not take into account social perspectives of learning such as Vygotsky's Zone of Proximal Development where a learner is able to perform at a higher level through scaffolding. As shown in Figure 10 below, a trainee could perform at a higher level and reduce cognitive load with the assistance of an instructor (scaffolding). In Figure 10 the lines A and B represent the trainee-performance without (A) and with (B) scaffolding. The reduced cognitive load and higher performance is argued to be beneficial for learning.

This social perspective relates to the previous mentioned studies of Koskela & Palukka (2011) and Sellberg (2018) where the role of the instructor and the interaction between instructor and trainee is emphasized, an aspect which would also be relevant in the remote tower setting.

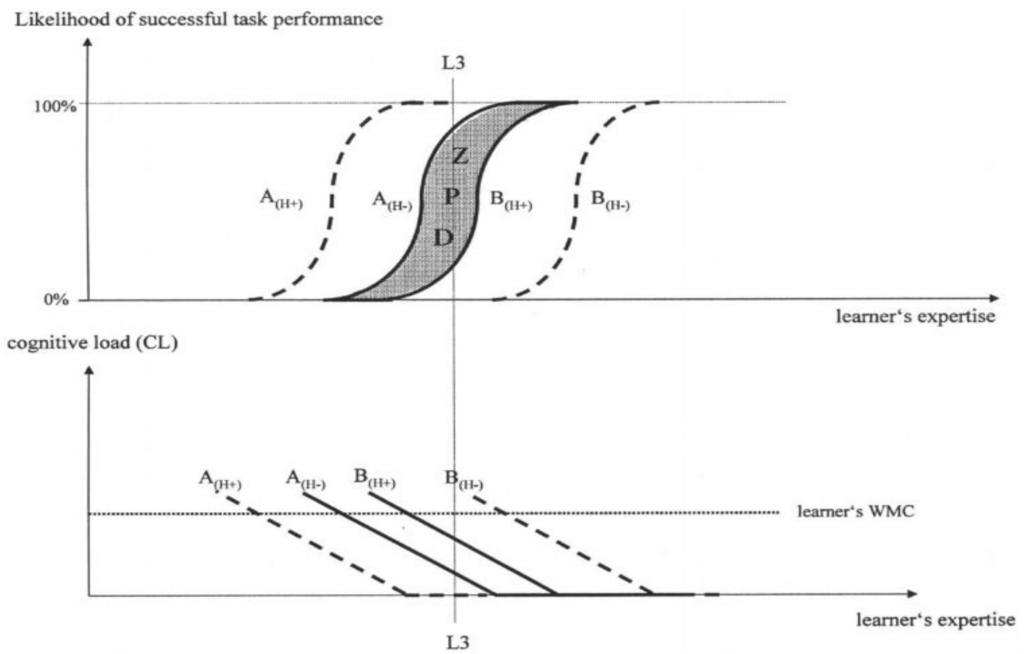

Figure 10. Task performance (top graph) and cognitive load (below) during performance of a complex task. Between A and B Vygotsky's zone of proximal development (ZPD) is shown, where line A shows the performance without and B with scaffolding. Reprint from Schnotz & Kürschner (2007: 489).

3.4 Regulation and implementation

Laws, recommendations and regulation with regard to the use of remote tower services in air traffic control has not been further specified. The use of video technology for the visual surveillance of an aerodrome is based on general regulations. Internationally these regulations come from the International Civil Aviation Organisation (ICAO) and in Europe, the European Aviation Safety Agency (EASA). As Schaik et al. (2010) notes, there is no specification on how visual surveillance shall be implemented, or what specific objects a controller must be able to identify.

In the area of ATC-training, and the use of simulation, the regulations are quite general as well: "As a general principle, the greater the degree of replication of the operational position being represented, the greater the use will be possible for any particular training." (EASA 2105: 11) For pre-OJT training EASA takes this one step further, mentioning that a high degree of fidelity is necessary if the simulator training is to be counted towards operational training hours. In the citation below the simulator is described as a STD which is short for Synthetic Training Device. SRA means Surveillance Radar Approach and is a specific sort of approach at an airport.

> *"When an STD is used for pre-on-the-job training and the training time is counted as operational training, the STD classification should be a full-size replica of a working position, including all equipment, and computer programmes necessary to represent the full tasks associated with that position, including realistic wind at all levels to facilitate SRA. In the case of a working position at a tower unit, it includes an out-of-the-tower view."* (EASA 2015: 11)

ICAO also mentions the use of simulators in more general terms. "What is important is that the simulation equipment used must be adequate to simulate the actual environment and enable the trainee to achieve the required competencies." (ICAO 2016: 59)

The final decision on how and if a simulator can be used in ATC-training is made on a national level. What seems clear is that higher fidelity is seen as a an advantage in training from a regulatory point of view, and in some cases it is a prerequisite if the training is to be counted as operational training time. The regulative perspective, as it seems, does not take into account recent research into fidelity, social perspectives, or the importance of different roles in training as discussed in the other parts of this section. This also shows the need for more research into this area.

4 Method

The overall purpose of this study was to explore the remote tower system as a training environment. Examingen new technology that has not been fully implemented yet has had implications for the choice of methods for the research. A qualitative approach using interviews with experts and a survey among ATC-trainees was seen as the most appropriate method gathering the required data. The method and related considerations are described further below.

In line with the suggestions of Repstad (2007) and Cohen, Manion & Morrison (2011), this study had an initially flexible approach depending on what kind of data was collected (and deemed relevant), and the availability of participants and locations. Data was collected from literature, a small scale survey and interviews with experts from different areas related to ATC-training and the remote tower system, such as aviation and maritime training. Starting with an orientation based primarily on literature and a global analysis of the remote tower system, the first steps were used to define a theoretical context and to investigate how different aspects of the remote tower system can be seen from the perspective of learning. The overall research-design is schematically shown in Figure 11 below.

Figure 11. The main methodological steps, and related goals, of the study.

The different methods have been chosen to fit the purpose, as well as to fit within the available time-frame of the study. This meant that some of the possible methods for exploring remote tower system as a training environment were considered less feasible considering available time, resources and relevance. For example, workplace learning is often studied using video-observation, where you can look closely at the different roles and interaction at the workplace. Koskela & Palukka (2011) and Sellberg (2018) are examples of studies using this method. Since this study takes a broad approach and the system itself (the remote tower system) is not readily available, it was deemed to time-consuming to use this method within the frame of this study. In short the following considerations were made:

- The study is exploratory in nature which means that the design had to be flexible and able to adjust to new insights/data.
- Remote Tower is new technology still in development. All possibilities of the system are not yet implemented meaning that to a degree the study aims to describe possibilities that can not be observed directly at the moment.
- Air traffic controllers and trainees are a limited population and not openly accessible. Gathering quantitative data would be difficult and time consuming.

Taking the above mentioned and the research questions into consideration, the chosen method was to use a small survey among ATC-trainees and interviews with training experts to get a deeper understanding of the possibilities of the remote tower system. Using interviews allowed for a non-structured open approach where relevant data could be collected from a heterogenous purposeful selection of participants. As the author of this study is a current employee of Air Traffic Control the Netherlands (LVNL) it was possible to gain access to experts and trainees that had otherwise been much harder to reach, something that has contributed to the possibilities for doing this research.

4.1 Survey

One relevant aspect of the remote tower system as a training environment, and a possible change occuring when moving the simulation into the workplace, is the experience of transfer from the simulated environment to the real. RTS is new technology and scarcely available, so to get a first insight into ATC-trainees attitudes and experiences with transfer of training the survey was held among trainees at LVNL. One must note that, due to the nature of ATC-training (i.e. one-on-one instruction and at the real working position) there are never large numbers of trainees available, and the number of participants are limited.

Trainees in the last part of the training, who has undergone simulation training and are now in the on-the-job phase, and trainees that had their exam the last year, were selected as possible participants. The reason for these criteria was to get participants who had recent experience with the transition from simulator to on-the-job training. From each unit the Training Managers were asked for a list of available trainees that met the criteria, which lead to a total of 20 respondents from all units: Amsterdam Aera Control (ACC), Schiphol and Regional Unit Tower/Approach (TWR/APP).

The respondents were sent an e-mail inviting them to participate in an online survey, explaining the nature of the study, and stating that their participation was voluntary and anonymous. The respondents were given approximately 3 weeks to fill out the form, including two reminders sent by e-mail. At the end of this period 14 participants had filled out the survey, which makes a response rate of 70%. Table 1 below shows the number of participating trainees per unit.

Unit	Number of trainees
Area Control Centre	5
Tower/Approach Schiphol	4
Tower/Approach Regional Unit	5

Table 1. Number of participating trainees per unit.

There is a general rule that a population of minimal 30 participants is needed to perform statistical calculations (Cohen et al. 2011, Barda & de Goede 2001). Since the goal was not to collect large amount of quantitative data for statistical analysis, but rather to get a first insight into the trainees attitudes with regard to aspects of fidelity and transfer, this was not seen as a problem.

The survey consisted of 15 closed and 4 open questions and was created as an online survey using Google Forms. The questions were based on different aspects of fidelity identified in related literature. It was designed to gather information about how trainees experience different aspects of simulator-training as playing a role in transfer from simulator to on-the-job training, which aspects they consider the most important and how they would rate these aspects in the current situation compared to an ideal situation. The survey design can be found in Appendix A.

The respondents were also asked to fill-in their most recent sort of simulator (Area Control (ACC), Tower (TWR) or Approach(APP)) this to be able to distinguish if there were any differences between the simulators. The reason for this was that ACC is working on a radar-simulator that could be considered a better replica of the real working-environment than the simulator of the tower or the regional approach unit. This could be an interesting factor to look into depending on the resulting data.

There were no way to connect the answers in the online survey to the individual participants which guaranteed their anonymity.

4.2 Interviews

To follow up the survey data, get a broader perspective and to get a more complete picture of the Remote Tower as a training environment and relevant aspects, interviews were held with experts in ATC-training and from different related areas. Participants were a selection of experts and trainees in the area of Air Traffic Control, Aviation and Maritime piloting, and consisted of operational personnel, course managers and instructors. Table 2 below gives an overview of the participants and their background. A total of 7 participants were interviewed and even though a larger sample would have been possible, it was decided to keep the sample size small considering the amount of data that was generated.

The participants were chosen through convenient purposeful selection, which meant that the participants were selected based on their background, accessibility and availability. The specific experts were selected based on referrals and recommendations from within the network of the author or their own organisations. Although this method of selection can be criticized, mainly based on the question of representativeness, often this is the only way to perform interviews in this kind of less accessible settings. Also it is the most effective way, selecting only relevant participants in a heterogeneous approach (Maxwell 2013: 97). The participants were contacted via e-mail or phone and the purpose of the study and the principles of voluntary and anonymous participation was explained. After initial contact and agreement on the participation, a meeting or phone-meeting was planned for the interview.

Function	Participants	Gender	Age
Air Traffic Controller, Instructor	3	Male	40-50
Air Traffic Controller, Training manager	1	Male	40-50
Air Traffic Controller, Trainee	1	Male	20-30
Aviation Pilot, Instructor, Human Factor specialist	1	Male	40-50
Maritime Pilot, Instructor, Course manager	1	Male	40-50

Table 2. Overview of interview-participants and their background. Age is indicated as a range.

Due to the exploratory nature of this study, the interviews were held as a semi-structured interview in the form of an open conversation about the key issues related to the remote tower as a training environment. As suggested by Barda & de Goede (2001) this form of interview is suitable to gain much information, insights about attitudes and gaining an understanding about the motivations and reasons.

Interview method:

- The interviews were held on a one-to-one basis, via phone or face-to-face depending on availability and planning of the participants.
- Interviews were audio-recorded.
- Relevant parts were transcribed and anonymized for analysis. Due to the open conversational style of the interviews, and the time available for transcription, the transcription was done in a summary manner as suggested by Taylor-Powell & Renner (2003).

The basic interview layout can be found in Appendix B, where the structure and questioning should be seen more as a rough guideline for the conversation than an exact interview-form. During the interviews, the basic layout and the identified theoretical aspects (Figure 8) served as starting point and frame for the conversation.

4.3 Setting

Survey data was collected among trainees at Air Traffic Control the Netherlands (LVNL), the survey was held online and all further contact with the participants were done via e-mail.

The interviews were held through phone or face-to-face at the respective organisations. The respondents consisted of experts from the following organisations: LVNL, Royal Dutch Airlines (KLM), Nederlands Loodswezen (the dutch maritime pilot organisation) and Luftfartsverket (Swedish Air Traffic Control). Some of the interview-data were collected at the Remote Tower Centre in Sundsvall where the remote tower system could be observed in action. This system, developed by SAAB and Luftfartsverket, is also the reference system for the study. It may be noted that the answers of the respondents reflect their personal experience and opinion, and are not to be seen as an official statement of their respective organisations.

Background information, technical data and photographs were made available by SAAB and LVNL.

4.4 Analysing the data

4.4.1 Survey data

Survey data was analysed using general numerical methods, calculating the mean scores, standard deviation and the overall ranking of the differents aspects. Mean scores and standard deviation calculation were done using standard functions in the spreadsheet program ‘Numbers’. The goal of the survey was to get an idea of the attitudes regarding transfer as input for the following interviews and to this aim and because of the low number of participants, there were no further statistical analyses done. The open-ended questions of the survey, where the respondents could give more information about their answers if needed, was included in the interview analysis. The goal of the overall analysis was to combine the survey and interview data to get a general idea. For the purpose of anonymity, analysing and result-presentation the survey-respondents were given a pseudonym: Survey 1, 2, 3, and so on.

4.4.2 Interview data

The interview-data was categorized using the theoretical aspects presented in Figure 8, above, as the main categories. The main themes were the following:

- Workplace learning
- Transfer of training and fidelity
- System functionality
- Cognitive aspects
- Implications for implementation
- Law and regulation

The different categories was then analysed for patterns and connections. This relates to the analysing method described by Taylor-Powell & Renner (2003) and Maxwell (2013). As Taylor-Powell & Renner (2003: 2) describes, the analysis was focused starting with the different topics. Reading the interview summaries, looking for themes and patterns as well as plain categorisation. The categorised data was interpreted making a connection between the findings and the starting point of the research, the research questions. As with the survey-respondents, to make a distinction between respondents, and to guarantee anonymity, the respondents were given a pseudonym: Respondent 1, 2, 3 and so on.

4.5 Ethical considerations

The ethical concerns in this study are primarily related to the methods of interview and survey. As suggested by Cohen et al. (2011), the participants and their organisations where informed about anonymity and voluntary participation beforehand to prevent problems around these issues. They were also informed about the nature of the study (a magisteruppsats), its aims, methods for data collection and dissemination of result. This was initially done via e-mail or by phone. When deemed relevant (such as in the case with trainees) the responsible manager was informed and his or her approval acquired beforehand. For the trainee-survey the request for participation went through the training managers for every participating unit.

To guarantee anonymity, parts of the data that could lead back to the respondent were anonymized. The respondents were given pseudonyms, Respondent 1, 2, 3 and so on, and the name of the organisation would be replaced with ´workplace´ in the transcript. This is one of the methods mentioned by Maxwell (2013). It was considered of less importance who specifically made a statement, than the more general themes and ideas. Participants could in this way not be traced back to there respective organisations which was an important aspect of anonymity with such low number of participants. In the case of the survey this was different with 14 participants, all from the LVNL.

5 Results

As stated in the research questions, this study set out to investigate how moving the simulator into the workplace can change training, how new functionality might affect training, and the practical implications for putting the remote tower technology to use in ATC-training.

Below the main findings are presented in short. There is no ranking between the different items listed. In the next section the results are presented more extensively based on the research questions.

Simulation in the workplace

- Using the remote tower system for simulation would take training to a new level of fidelity.
- Simulation in the Remote Tower System could improve training by increasing fidelity and reducing transitional effects.
- The social and team aspects of training are largely missing in the simulator-training today and this has a negative effect on the experienced transition from simulator to on-the-job training. Training in the real work-environment might improve this.

Functionality

- Projecting information direct on the screen could have a positive effect by reducing head-down time (time looking away from your primary screen) and improve situational awareness.

Implications for implementation

- Higher realism could result in more simulation and less on-the-job training, this would make the training more efficient.
- Using identical systems for different working-positions and training will improve the transition between these settings and reduce training-time. This could be from simulator to on-the-job, but also in a centre setting training for a second airfield.

5.1 Simulation in the workplace

The interviews showed that moving the simulation into the workplace could increase fidelity and facilitate transfer, which is expected to shorten training time. For this reason it was considered a great advantage by all interviewed respondents. The expert-group considered overall fidelity as very important for the transition from simulator to work-environment. Two respondents even called it the ‘holy-grail’ of training from the perspective that in an ideal situation the training environment is a full replica of the work-environment, meaning that there should be no transition at all, and no transfer needed. Moving the simulation into the workplace as would be possible in the remote tower system was seen as an important step to achieve this. As Respondent 1 puts it:

> *“You see that trainees have a smoother transition from simulator to on-the-job training when the environments are alike, here you could have a great advantage with remote tower”.* (Respondent 1)

The trainee survey indicates that all scored aspects are seen as important for facilitating transfer from simulator to workplace. Table 3 shows how the different aspects were scored on how important they were thought to be for transition and transfer. Realism of the outside view and the behavior of the simulation are seen as the most important.

In contrast, the realism of the outside view were not considered the most important in the opinion of the interviewed respondents. In the interview-data, key aspects of the outside simulation, aspects considered relevant for the training-goal or exercise at hand were considered the most important. As an example, the runways, taxiways and relevant orientation points in the surroundings would be considered relevant and detailed graphics of trees in surrounding forests not. An explanation for the difference in survey and interview data could be the different perspectives of the participants, trainees might be more task-oriented and the experts more focused on training-aspects.

Scored aspects ranking - overall trainee opinion	***M***	***SD***
1. Realism virtual environment	9,07	0,73
2. Behavior of the simulation	8,93	0,92
3. Exercises and scenario	8,23	1,20
4. Behavior of machine	8,21	0,89
5. Role and interaction instructor	7,76	1,48
6. Realism physical environment	7,43	1,40
7. Realism social context	7	1,41

Table 3. Aspects relating to transfer from simulator to real working environment as scored by the trainees. Mean scores (M) and calculated standard deviation (SD) are shown.

Many of the open comments from the survey were made with regard to the lack of realism in the behavior of aircraft in the current simulation (turns, speeds, reactions of pilots), for example:

> *"The influence of wind and the speed of aircraft is not always realistic."* (Survey 11)

This was supported by the findings from the interviews, although the reasons for the unrealistic behavior vary:

> *"The simulator pilots are too good, in reality not all pilots understand what you want, or answers your calls directly when it is busy."* (Respondent 1)

The overall transition was scored an average of 4.5 in the survey (on a scale from 0-10, where 0 indicates no transition). The indicated time needed to adjust from simulator to OJT varied from less than 1 week to 3-4 weeks with an average of about 2 weeks (Figure 12). This indicates that there is some experienced transition in the current situation which might be improved.

The social aspects of training was also a returning item. It was clear from the interviews as well as from the surveys that training in a team-context is missing in the training today and that this has a negative effect on the experienced transfer. Cited below are a selection of answers from the interviews, relating to the social context:

> *"There is a lot going on around you at the workplace that is not part of the simulation, and this influences your own process."* (Respondent 3)

“In an ideal situation you train with the whole team together. When doing so, you would get the maximum out of the training.” (Respondent 1)

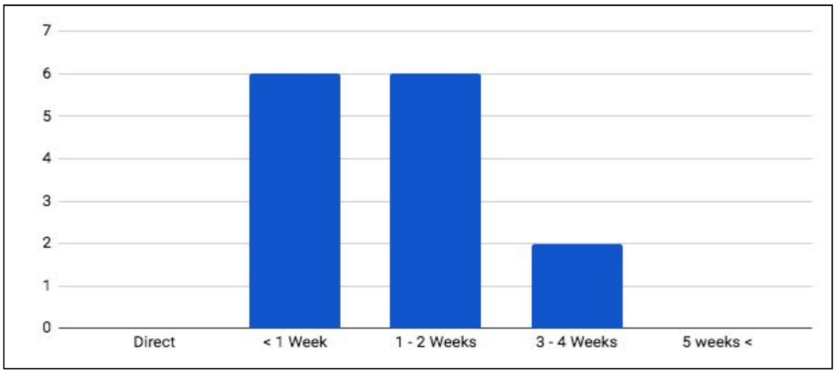

Figure 12. Estimated transition-time from simulator to on-the-job training. The bars show number of responses per category.

Although the general tendency was that the social and team aspects are missing in the simulator today, the question was also raised if all of these aspects can be simulated. Getting to know colleagues and becoming a team-member were mentioned as aspects that would be hard to integrate in a simulation.

From the perspective of flight and maritime training, team resource management (TRM) was considered an important part of training and something that should be integrated in the simulation if possible. This is supported by recent research (for example see Sellberg 2018) and was also brought forward in the interviews:

“We are trying to integrate non-technical skills in the simulation as well. Subjects such as decision making and problem-solving, previous trained mostly in the classroom, are now an integral part of the simulation.” (Respondent 2)

How the TRM-training was done more specifically in these cases, and if using the remote tower system could have an affect on this, was not clearly brought forward in the interviews. The interviewed respondents did agree that integrating the simulation at the workplace could improve the social aspect of training in more general terms. Respondent 2 says the following, referring to the absence of teamwork in the simulator today:

“It is a shame that you don’t have the same tasks in the simulator as in reality, you don’t learn the teamwork this way”. (Respondent 2)

As can be seen in Table 2 the TWR/APP trainees scored the social context in the current situation a 4.4 on a scale of 0-10. Interesting to note is that the social context was considered the least important of the identified aspects in the survey (Table 3), but in the comments and from the interviews this seems to be one of the more important aspects. A reason for this could be the more open discussion possible in the interviews, where the survey was designed to give a ranking between predefined aspects. The survey data in

Table 4 have been categorised according to unit. As can be seen there is a difference between ACC and TWR/APP with regard to the scores of the current situation. ACC scores higher at all aspects which means that the ACC-trainees rates there current simulator higher towards an ideal situation than TWR/APP does. This might be explained by the higher level of fidelity in the ACC-simulator, but this need further research to really explain these results.

Scored aspects - trainee experience of the current situation	**ACC N=5**	***SD***	**TWR/APP N=9**	***SD***
Realism physical environment	8,6	0,89	6,3	1,73
Realism virtual environment	7,4	0,54	6,4	1,33
Realism social context	7,6	1,52	4,4	1,88
Behavior of machine	9,2	1,1	6,1	1,61
Behavior of the simulation	5,6	1,82	5,3	1,22
Exercises and scenario	6,8	0,84	6,7	2,06
Role and interaction instructor	8,6	1,14	7,9	0,93

Table 4. Aspects relating to transfer of training and how the current situation were scored. Mean scores and calculated standard deviation (SD) are shown.

5.2 Functionality

All interviewed respondents were positive about using the new functions of the remote tower system for training. In the opinion of the interviewed respondents, overlaid information such as meteorological data and tracking labels should reduce head-down time and increase situational awareness which in the extension could support the learning process. The citation below is how Respondent 3 explained this:

> *"Today there are different systems in the control-tower for supporting the situational awareness and to know where to look for an aircraft. Think about the direction finder or radar screen. Training to be an air traffic controller you have to learn how to interpret the equipment and how this translates to the outside view. This costs bits and bytes in training. Also it can be hard to identify an aircraft a few miles away due to visibility conditions. If all data where available directly on the outside view screen this would make the learning process easier."* (Respondent 3)

A returning argument for why functions of the remote tower system would have a positive effect on training was increased situational awareness and reduced workload. This was an expected effect from overlaid information on the screens as presented above. Other functions might have a more specific training-value. Mentioned functions include: Using screens means that the outside view or simulation could be recorded and used for evaluation and feedback, digital strips with integrated administrative functions where considered supportive of training due to a simplified workproces, and projecting traffic on top of the real outside view (Mixed Reality) was thought interesting for low volume airfields with periods of no traffic.

5.3 Implications for implementation

The specific implications for the practical implementation of the remote tower system were threefold:

- Practical implications regarding the use of the remote tower setting when adding an airfield to a remote tower centre.
- Implications for the legal status of simulation-training in the remote tower system.
- The possibility to train more simulated and less on-the-job.

Simulating in the workplace would mean that the environment where you train is identical to the work environment. As presented above, this is expected to reduce negative transfer-effects and improve the transition from training to work. The conversations held with experienced personnel at the remote centre in Sundsvall indicated that the identical settings was a great advantage when training.

> *"Because of the identical environments the training-time for a second rating can be reduced significantly."* (Respondent 6)

The system hardware, position of screens, workings of the different pieces of the equipment, are basically the same between airfields. Training for more than one airfield was experienced as easier than before due to this work-position similarity and the centre setup (controlling more remote airfields from one location). So not only moving from training to work, but also the transition from one airfield to another was improved in this case. In the respondents experience this reduced training-time for a second airfield significantly. Different scenarios where this principle would be applicable were mentioned, such as: you can start training in the work-environment before the airfield itself is ready, as is the case when a completely new airfield is being build, or if you make a transition from a regular tower to a remote tower solution.

If training time in a simulated environment is to be counted as operational training-time the simulation has to have a high degree of realism. Although the respondents viewed this question mostly from a training perspective, it was clear that practical considerations such as rules and regulation play an important part for the practical implementation. Using the remote tower system for training as well as work, mean that you have a full replica (or the actual working environment) to train in. This could mean a new level of fidelity in training and also more possibilities conforming to required regulational demands.

Simulating at the real workplace could also make the training so real that you could train more simulated and less with real traffic, something which could mean more efficient training. Especially for airfields with low traffic volumes this could be the case. Respondents from different areas supported this idea; In flight training they can train fully in the simulator (called Zero Flight Time Training, ZFTT), and in a maritime setting simulator time counts double because it is considered more efficient than OJT as brought up by the respondents. If the simulation and the training environment is realistic enough, this was seen as an option in ATC-training as well by all respondents. Although one respondent expressed doubts about if this would be possible for one hundred percent, all agree that the simulator training could be a very large part of the training, shortening the on-the-job training to a minimum.

6 Discussion

The purpose of this study was to explore the Remote Tower System as a training environment. Because this new technology has not been implemented fully yet, some of the aspects of the system had to be discussed in a more speculative way. The new possibilities have been explored against a background of related work and personal expertise as described in the previous sections. In this sections the results and related work will be discussed further.

One of the possibilities of the remote tower system is to use the workplace for simulation as well. This has been one of the central concepts of this study (as shown in Figure 1). The results show that moving the simulation into the workplace should have a positive effect on the overall fidelity of the simulation, and it also relates to the perspective of workplace learning as a situated practice.

Situated learning or the concept of community of practices gives a theoretical background to learning at the workplace. As discussed in section 3, workplace-learning is one of the relevant aspects of remote tower training (see Figure 8). From this perspective a trainee is learning a skill and becoming a member of the community at the same time. The skill is also seen as a part of the social (situated) context (Lave & Wenger 1991). It is interesting that the simulators used today, and especially for the Tower/Approach unit, does not seem to take this perspective into consideration. That this is an important factor contributing to the experienced transfer effects was clear from the results of this study, indicating that being able to increase the social fidelity could reduce these effects. Speculating about how this could be done was not part of this study, but according to some respondents there were doubts if this aspect could be simulated fully. From that point of view, it means that a transition towards training only in the simulator (no on-the-job training) can be very challenging. This can be compared to the concept of Zero Time Flight Training in aviation, where they do all the training in the simulator.

In flight training, the concept of Zero Flight Time Training has been used since the early 80s, showing that a transition towards more simulation and less OJT should be possible. LeTellier (2011) describes a balance of 90% simulation training and 10% OJT in ATC-training, indicating that a movement towards more simulator training should be possible. In general terms this was supported by the results, where the remote tower system was seen as a natural way of achieving this based on the idea of increased fidelity. International regulation (EASA 2015) also supports the notion that high fidelity simulation is needed if training-time is to be counted towards operational training.

Although all respondents agreed that more simulation and less OJT should be possible, the study did not give any concrete indications on what the effects would be in terms of reduced training-time. Based on related work, it is plausible that the effects could be significant, especially for an airfield with a low traffic load. You could easily see how low traffic volumes makes it difficult to build routine and to practice. This thought finds support in the theory of Above Real Time Training, as described by Schneider (1985), where the importance of repetitiveness of a task is seen as very important. In short, to build routine you have to perform a task over and over again within a reasonable timeframe. Even more simplified, it is challenging to learn any task without the possibility to perform the task itself.

As described in section 3’, there are many cognitive aspects to the functionality of the remote tower system. Schnotz & Kürschner (2007) make the argument hat cognitive load theory misses some of the social aspects and possibilities of training. This also indicates the need to investigate the social dynamics further. The simulator (or workplace) does not train by itself but is a tool and environment for learning (Sellberg 2018, Rystedt & Sjöblom 2012). The effects of scaffolding (Figure 4) for example could have an impact on cognitive load and learning. Here the role of the instructor and the importance of trainee-trainer interaction becomes clear. Koskela & Palukka (2012) examined the interaction between trainee and trainer, and also stressed the importance of better integration of simulation and workplace. The remote tower system with built in simulation capability could do just this, integrate simulation and workplace.

Due to the chosen methods for this research, the results relating to social aspects of training have been limited to the opinion of experts and trainees. There was no possibility to examine the roles during workplace-training or the trainee-trainer interaction during remote tower training. The main reasons for this was time and availability limitations. Aspects relating to the more social aspects of remote tower training as well as workplace and training interaction now remain to be investigated.

One of the main results from this study relates to how fidelity might improve by using the workplace for simulation. It was clear in the interviews that the experts all thought fidelity of the simulator was a very important aspect of the simulation. With regard to regulation, this is also one of the demands on a simulator if training time is to be counted as operational training (EASA 2015). Recent research in this area takes a more pragmatic stance, where the training-goals are leading for what kind of simulator is needed for any specific training (Norman et al. 2012, Harman et al. 2014). This contrasts the collected data to some extent where the possibilities found in the remote tower system were mainly contributed to the expected increase in fidelity from moving the simulation into the workplace, and the effects this is expected to have on transfer. To a degree this result may be contributed to the fact that practical obstacles such as costs and rostering of personnel was not taken into account in this study, where this is brought up as an argument to use a lower fidelity simulation in some studies. The decision to exclude these factors from the study was based on the idea that the main focus at this stage should be the full potential of the system, not practical obstacles.

Fidelity has many dimensions and to discuss fidelity in a more specific way can be problematic because of these many different aspects (Hamstra et al. 2014). Fidelity as a more general concept of simulator authenticity is less problematic and it was found with the survey and in the interviews that this worked well. In part this might be because of the identified aspects of fidelity that served as base for the survey, this way the fidelity concept had been predefined to some degree. This also means that other possible aspects of fidelity were not part of the survey, aspects considered less important for transfer were omitted, which also is reflected in the survey data (see figure 5). All aspects score relatively high (>7) when asked if they were thought important for facilitating transfer.

Although the combination of workplace and simulation is a new possibility emerging in the remote tower setting, simulation and workplace learning in itself is not. This means that some of the aspects in this study are applicable not only to the remote tower setting but to other contexts and applications as well (for example simulation in itself is not specific for the remote tower system). This also relates to the chosen groups of participants. The availability of experienced personnel, that had worked with and trained in the remote tower system, was very limited. Many of the possibilities of the system are also not yet in use, which means that even if the previous mention personnel were widely available they could only speculate over the impact of new functions and features. The choice then was to put together a broad group of experts not only from air traffic control, but also other areas where they have extensive experience of the use of simulation and workplace learning. Doing this meant that the results are speculative and explorative (as the study itself) but also that it gives a broad view and is based on years of expertise.

As mentioned above, moving the simulation into the workplace is one of the main changes possible with the new system. In a more general sense the use of screens instead of plain windows gives a lot of new technical possibilities. Almost all of the new functions described in this study are dependent on this to some degree.

The functionality of the remote system and its effect on training is maybe the most exploratory part of this study. Most of the functions are not in use today, which means that even if they are part of the system capability, no one has any real experience with these functions as part of a training environment. Expected effects are based on speculation of experts and indirect evidence from related work. Reduced workload and increased situational awareness and how this could affect training is an example of this way of reasoning (see for example Sweller 2011 and van Meeuwen 2013 for the mentioned theory), where the principles themselves have been studied and proven before in a variety of other areas. At this stage of research, exploring new technology, this was not seen as a problem. It is clear that more research will be needed to prove that these implications and possibilities for the remote tower system will hold up as implicated.

A large part of this study has been focussing on the system itself, the possible functions and how this could affect training. Looking at implementational aspects of the system adds a more practical dimension. As presented in the results, there are practical benefits implicated using the remote tower system. In a centre setting the transition between airfields (requiring transition training) could be improved by using identical systems. Although this principle seems straightforward enough, to be able to get a more concrete idea of how the implementation could affect training would require more study. Effects could also vary depending on national regulation and the training requirements at the specific concerned unit, which might make it hard to do any general statements in more detail.

There are strong indications that the remote tower system could have a positive impact on training. The results from this research in combination with previous related work points in that direction. Fidelity can be increased to a new level, new functions could support learning and you could even imagine how new functionality could be developed especially for this purpose. The next step should be to investigate this further. How can we put this to use and what are the effects to be expected?

7 Future research

There is more research needed to measure the real-life effects of the implications identified in this study. Although the results give an idea of the possibilities of the remote tower system, they are to a degree speculative. As the system is implemented on more airfields, and new technology and functions are operational, the possibility to study the effects of the system in a more direct way should be increasingly available.

The use of simulation in the workplace and the effects that this has on training in terms of shorter training-time should be studied more closely, which aspects of fidelity are important to facilitate this? Effects of the different functions available in the system should be studied further, how does the functions impact workload and situational awareness, and does this have the expected effect on training? Can new functionality be developed to support learning based on the technical possibilities of the remote tower systems? How can the system be implemented in the operation in a way that transition from one airfield to another is facilitated as efficiently as possible? Which factors could contribute to this (such as regulations, procedures, identical machine interfaces and functions)?

As described above, the system seems to have a lot of potential. There is also a lot that need to be studied to fully understand the effects and potential of this new technology. A first step in making this possible is the availability of the system on a larger scale and gaining experience in the workings of the system as a training environment. Let’s investigate!

8 Conclusion

The studied remote tower system has a potential to have a positive effect on ATC- training. The presented results show that moving the simulation inte the workplace could increase fidelity and improve transfer, reducing training-time. Training at the workplace is also considered to potentially improve the social aspects of training, an aspect also in line with recent research (for example Koskela & Palukka 2011).

Functions build-in to the remote tower system, overlaid information, tracking labels, visual enhancement and simulation, were all considered valuable for training. The overall consensus was that these functions could make a meaningful contribution to training by reducing workload and increasing situational awareness.

The higher level of realism expected from moving the simulation into the workplace should make it possible to train more simulated and shorter on-the-job. This would be a step towards the concept of Zero Flight Time Training as known in aviation. Regulation with regard to use of simulators in operational training seem to support the idea of increased reality as a prerequisite for training this way (EASA 2015).

Using the remote tower system in a centre setting gives advantages when training for a second airfield, or adding new airfields to the centre setting. Identical environments shortens training-time and training in the remote system can start before the airfield is fully operational, saving time and increasing efficiency.

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Frontpage image:
Remote tower setup at Sundsvall Airport, Retrieved april 2018 from https://saab.com/globalassets/commercial/security/sdats/media/topclass_2340x1316.jpg

10 Appendix A - Survey Design

Short survey about transfer in training

Participants:
Area Control Centre (ACC)-, Tower/Approach- and Regional Unit (RU) Trainees
(trainees during Unit Training and recently finished trainees)

At which unit do you train: ACC, TWR/APP, RU
Which simulator does your answers relate to: ACC, TWR (SPL), APP (SPL), TWR (RU), APP (RU).

Rate your overall experience of the transition from simulation to OJT:
0 = no transition, it was as if I continued working, no change.
10 = Very different experience, a lot of things were different or behaved in another way., it took time and effort to get used to.

Comments:

How much time did you need to adjust to the new setting (OJT)

(<1wk, 1wk-2wk, 3wk-4wk, 5wk or more)

Comments:

Score the simulation-factors below on how important you think they are for the transition from simulation to OJT.

0 = not important, doesn't matter, 10 = very important.

Likeness of simulator equipment (does the simulator look like the real thing)
Likeness of synthetic environment (how real is the graphics, outside view)
Likeness of work setting (colleagues, how is the team setup during training)
Behavior of equipment (buttons, phones, wind meters etc.)
Behavior of simulation (does the aircraft behave realistically).
Role of instructor (does the instructor play a part in the transition)
Exercises (does the exercises feel real and relevant)

Score the simulation-factors below on how you experienced them in the simulator, how does these compare to an ideal situation.

0 = Very bad, a lot of room for improvement. 10 = Perfect as it is now.

Likeness of simulator equipment (does the simulator look like the real thing)
Likeness of synthetic environment (how real is the graphics, outside view)
Likeness of work setting (colleagues, how is the team setup during training)
Behavior of equipment (buttons, phones, wind meters etc.)
Behavior of simulation (does the aircraft behave realistically).
Role of instructor (does the instructor play a part in the transition)
Exercises (does the exercises feel real and relevant)

Comments:

11 Appendix B - Basic Interview Layout

Remote Tower Training, Simulator, Simulation fidelity and experienced transfer

(KLM, Loodswezen, LVNL, LFV)

Goal: Collecting experiences and attitudes regarding Remote Tower Training, use of simulators in training, fidelity and transfer from simulator to 'live' practice.

Respondent background

Organisation
Function
Years of experience within field
Years of experience simulation in training/education
Age
F/M

Experience with the simulator: Training / Trainee / Instructor / Developer

Simulator:

Thoughts on RTS as a training environment

Thinking of RTS as an ATC training environment, which new possibilities (functional, social etc.) do you see?

How can these be used for ATC training in the future?

In the RTS the simulation can be moved into the workplace. What do you think about this?

Could this influence training in any way?

Why (or why not)?

Transfer, fidelity and social context might be different in a RTS compared to the more traditional use of simulator and OJT. What are you're thoughts on this?

Simulator use and training

To what purpose do you use the simulator (recurrency, new personal) today?

Looking at your training-trajectory, how much time is spent in the simulator and how much time is spent in 'live' training (sim/ojt ratio)?

Why use a simulator at all (money, safety, traffic, controlled environment, other)?

How do you use the simulator? as a safe version of reality or more like a training tool with specific training functions.

Fidelity

In you're opinion, how important is it that the simulator looks and feels like the real thing?

Why?

Is the simulator you are used to a good match to the 'live' situation?

Which simulator-factors do you think are the most important for the simulator to be a useful training tool (likeliness of environment or graphis, behavior of simulation, scenario, other)?

Why?

Transfer

After the simulator-training, when starting 'live' practice, how much of a transition did you experience?

Where there aspects that needed more attention than others?

How long did it take to get comfortable in the 'live' situation (and where you confident coming out of the simulator)?

Which factors are important to facilitate transfer of training (fidelity, behavior, scenario, interaction with coach or team, other)?

Why?

Social and contextual aspects

When working 'live', are you working alone or in a team (together with other people)?

If in a team, who?

How did this look like in the simulator?

Explain?

Are there any differences?

(if any) How does these differences influence the simulator training?

Are there other differences in a social context, and how does this influence training?