Investigating Augmented Reality's Potential Disruptiveness

A Case Study On Combining Disruptiveness With Aspects of Diffusion at Mixtive

Master's thesis in Management and Economics of Innovation

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Gothenburg, Sweden 2021
www.chalmers.se
Report No. E2021:062

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Cover:
Person using AR-glasses Magic Leap. Photo credit: https://unsplash.com/@mynameisyanick.

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SUMMARY

The development of Augmented Reality (AR) has been rapid during the last couple of years and it has in many cases been viewed as a hyped technology. Still, it is considered a promising, emerging technology that can provide great value for businesses and consumers. Some argue that AR will disrupt several markets and industries, and in order for businesses to succeed in such an uncertain market, an understanding of the technology's disruptive characteristics should be considered. This thesis aims at investigating how AR can be described as a disruptive innovation and combines the results with aspects of diffusion and technology life cycle analysis in order to guide the IT-company Mixtive in their future work with AR. In order to conduct this research, 17 qualitative interviews were held with actors involved in product development and sales, as well as representatives with insights in the technology and related research. The results show that existing solutions often see sustainable development with signs of technologies overshooting existing demands and opportunities for discontinuities, however still with demands changing and growing within the area of communication and especially collaboration. Consequently, there are many possibilities for AR within these areas, but the technology is argued to face many barriers for further adoption and diffusion, with the quest of reaching ease-of-use in combination with an undoubtful value proposition being one such barrier. Furthermore, AR shows signs of disruptive characteristics for certain applications, due to its new set of attributes as well its related financial unattractiveness and market uncertainty. However, while providing solutions often aligned with existing needs of customers, the disruptive capabilities diminishes. In conclusion, Mixtive is recommended to develop AR solutions with clearly defined scopes that do not seek to replace existing solutions, as well as being flexible and ready for future development in the industry.

Keywords: Augmented Reality, Disruptive innovation, Emerging technologies, Diffusion, Adoption

Acknowledgements

With an initial thought of a technology potentially being disruptive in a sense that it could drastically change industries in the upcoming years, the authors together with Mixtive developed an idea that could answer how companies could tackle future challenges within the industry. This thesis was written in the spring of 2021 at the Department of Technology Management and Economics at Chalmers University of Technology.

We would like to thank our supervisor, Erik Bohlin, for his support and feedback throughout this project. We would also like to thank Magnus Willner, CEO at Mixtive, for his support, supervision and commitment to the project with great discussions and insightful comments. Last but not least, we would like to dedicate a big thank you to all the interviewees for taking their time to answer our questions and contributing with valuable knowledge and insights.

Without the aforementioned actors, this thesis would not have been possible.

Hampus Frodell Adam Olivegren

Gothenburg, Sweden. May 30, 2021

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1
Introduction

The following chapter presents a background to the paper, introducing Augmented Reality and the company Mixtive to the reader. Subsequently, the paper's purpose is presented together with the research question as well as its scope, delimitations and disposition.

1.1 Background

Augmented Reality (AR) has seen an unprecedented growth during 2020, with growing numbers of use cases across all industries (Makarov, 2021). Companies such as Microsoft, Facebook, Google and Apple strive for market leadership in the rapidly growing sector, hence making their best efforts in reaching both businesses and consumers with their products and services. Clearly, it is a technology that for a long time has been seen as a promising, future technology (Porter & Heppelmann, 2017). Porter and Heppelmann (2017), argue that AR is to become the new interface between humans and machines, bridging the digital and physical worlds. It is said to potentially disrupt several markets and industries (Langmeyer, 2015), and is together with Virtual Reality (VR) seen as the most disruptive technologies of the decade by numerous authors, institutions and organisations (Schultz, 2020; NEC, 2020). However, some reflect on the disruptive capabilities of AR. Disruption is about more than great potential, business transformation and profitability (Naisby, 2018). Hence, a further understanding of AR is relevant for businesses, navigating through markets of emerging technologies.

This future technology could now be ready to emerge in today's technological landscape and empower consumers, companies and overall society. AR can be used in retail similar to what IKEA accomplished in their AR-app IKEA Place (IKEA, 2017), for remote guidance like XM-Reality do (XM Reality, 2021) or as a tool used for educating just as Eon Reality do (EON Reality, 2021). AR combines the real environment with virtual objects that appear to co-exist in the same space in real-time (Azuma, Baillot, Behringer, Feiner, Julier & MacIntyre, 2001). The virtual object can be a static sofa from IKEA, a moving hand from the support-function at a telecommunication company or a spinning motor from Volvo. The various applications illustrate its potential, especially when put in the context of the technology's associated components and its rapid development. What years ago demanded expensive and inaccessible hardware can today easily be experienced through a smartphone (Boland, 2020).

Mixtive, an IT-company based in Gothenburg, seeks to be a part of the industry's future development. As a part of the company group Inceptive Group, Mixtive strives to exploit in-house competence across the entire IT-spectrum and develop solutions with AR and VR. Having a portfolio of products, yet without the desired company growth, the executives renewed its vision during 2020. As of today, Mixtive concentrate their efforts into three areas; *collaboration*, *conversion* and *education*. In conversion, Mixtive delivers solutions within, for instance, e-commerce, assisting customers in their purchasing process and allowing them to visualize their future products in an augmented reality. In education, Mixtive helps companies and organisations spread knowledge in more engaging ways, for example by turning school tasks into games that are displayed in AR through the students' smartphones. Lastly, Mixtive empowers companies' communication and collaboration both towards customers and between employees, enabling new ways to communicate with AR and VR where users are able to interact with each other as virtual avatars. Also within collaboration, Mixtive develops solutions where individuals can co-create and interact with 3D-models in real time with the use of AR.

This paper seeks to create a better understanding of AR and its market in order to guide Mixitve in their future development. With the underlying assumption that the market is in a rapidly growing phase, with undiscovered areas of utility and potential, the opportunities are many but so are the challenges. The authors aim to define how AR is potentially disruptive, in the contexts of a highlighted potential with new products and opportunities, in order to help Mixtive realize further opportunities. Christensen et al. (2015) argue how this understanding is crucial for managers, especially while "*...the 'disruptive' label has been applied too carelessly anytime a market newcomer shakes up well-established incumbents*". They illustrate how managers lacking understanding of the nuances of disruption theory or the applications of its principles may make wrong strategic choices.

Mixtive demands a deeper knowledge for the market's current state and criterias for diffusion in general, and a renewed strategy for their work within the area of communication and collaboration in particular. A product named AR Call has been an ongoing project for a few years, with involvement from e.g. Telia Company. The product, which through AR allows for communication with life-like avatars and shared 3D objects in real-time, has seen some traction but not in line with Mixtive's ambitions. For this reason, Mixtive now determinately pursues a new product strategy, with the intention of rephrasing it and thereafter investing the necessary time and resources for further progress.

1.2 Purpose and Research Questions

This study has a twofold aim in investigating AR's disruptive characteristics and creating a generic understanding of the market, as well as specifically guide Mixtive in their work with AR. In order to do so, the following research question has been formulated:

- How could Augmented Reality potentially be described as a disruptive innovation?

Answering how AR is, or is not, a disruptive innovation will implicitly result in conclusions regarding how to best make business decisions concerning the technology. Thereafter, an understanding of AR's continued possibilities for diffusion and adoption through its prerequisites for utility and value creation is sought for in order to apply the understanding of disruptiveness in the guidance of Mixtive in their future work with AR. Therefore, an additional research question has been formulated:

- How should Mixtive purse further work with Augmented Reality with respect to its disruptive characteristics and aspects of diffusion?

1.3 Scope and Delimitations

Firstly, this paper examines only the application and understanding of AR technology and consequently not VR, despite the technological relatedness and Mixtive's focus on both. The paper's ultimate objective concerns Mixtive and their potential customers within communication and collaboration in Sweden, resulting in great potential to give strategic advice to Mixtive about their strategy regarding the communication and collaboration tool AR Call. The abductive approach however opens up for a broader discussion and general understanding that is necessary to make specific conclusions.

Secondly, AR as a potentially disruptive technology is evaluated from the perspective of Mixtive, meaning that their potential products and applications are discussed. The perspective analyzing whether Mixtive could disrupt different markets with their technology is therefore highlighted. Furthermore, since AR is discussed to be a future general purpose technology, it is also mentioned in the analysis, yet not in depth due to the study's focus on Mixtive and more specific applications of AR rather than the technology in general.

1.4 Disposition

This initial chapter provides the reader with a background to the research questions, hence clarifying its relevance and purpose. In the following two chapters, a literature review on the associated topics are first presented in order to strengthen the theoretical reasoning, followed by a chapter that clarifies the study's methodology. The empirical results are presented in the fourth chapter, firstly with a part based on secondary data on AR, followed by a presentation of the results from the conducted interviews regarding both the technology, the market and Mixtive. With all relevant data presented, the final two chapters contain the complete analysis of all collected and combined data which then introduces the conclusion, summarizing the findings and giving further recommendations for Mixtive.

2

Literature Review

In the following sections, several theories are presented to provide knowledge in order to answer the formulated research questions. Firstly, a chapter regarding disruptive innovation is presented with a basis on the work of Bower and Christensen (1995). Secondly, with main takeaways from Utterback (1994) as well as Taylor and Taylor (2012), the concept of the technology life cycle is accounted for. Lastly, theories on the diffusion of innovations are presented, with a primary focus on the work of Rogers (2003).

2.1 Disruptive Innovation

In their work *Disruptive Technologies: Catching the Wave*, Bower and Christensen (1995) define the idea of disruptive technologies. In his succeeding work, Christensen (1997) builds on the previous and coins the term disruptive innovation, while discussing value networks and resource dependency as important aspects in the understanding of innovations and their potential to disrupt industries. Christensen (1997) describes the phenomenon in order to show how companies can do everything right, yet still lose market leadership, and describes it with the work's title; *The Innovator's Dilemma*. He explains it as the operational contradiction in listening to existing customers and using the right methods, only in order to see oneself misvalue new innovations, especially those that are disruptive. Primarily, disruptive innovation is about technologies that at some point underperform in relation to existing technologies, yet creates a new value network that in later times disrupts an established market, indicating a demand for not only new markets but also the creation of such (Christensen, 1997; Bower & Christensen, 1995).

While defining disruptive technologies, Bower and Christensen (1995) clarify the following three potential characteristics:

- Firstly, such an innovation could introduce a different set of attributes in comparison to existing solutions and also perform way worse in one or two dimensions that the incumbent firms' customers value. Christensen (1997) further explains how such innovations, those that are not compatible with current customers' demands, competitors' actions nor with a higher product quality than previous models, enable new value propositions. Consequently, previous customer demands should therefore be assumed to oppose the possibilities of the disruptive technology in applications which they know and understand,

while seeing some particular performance dimensions being underdeveloped Christensen (1997).

- Secondly, Bower and Christensen (1995) clarify a potential characteristic in that the innovation is considered financially unattractive for incumbents. Incumbents are assumed bound in rationality, incapable of focusing on more than satisfying current customers, implying how a focus on potentially less-profitable products offered to non-existing customers is unreasonable from a financial perspective.

- Thirdly, a disruptive innovation and its future market could also be difficult to understand and predict, implying an increased risk and further financial unattractiveness. It is irrational for managers to pursue work in such a market since the necessary time and effort cannot be justified in relation to company growth (Bower & Christensen, 1995).

Similar to Christensen's definition of disruptive innovation, Schumpeter (1934) describes a process that sees new innovations replacing existing ones that are rendered obsolete over time. Schumpeter calls this process *creative destruction*. Creative destruction and disruptive innovation are however distinguishable and can be seen in the example of the sailing ships' development in the late 1800's. The steam engine, a possibly disruptive innovation, forced sailing ship companies to innovate and resulted in an increased performance. This phenomenon, when a new technology is introduced and stimulates the innovation of the incumbent technology, is defined as the *sailing ship effect* (Ward, 1967). Nuancing the previous work, Christensen et al. (2015) emphasize the importance of understanding disruptive innovation as a process, as *disruption*, describing it as when a smaller company with fewer resources challenges incumbent firms. This imposed threat materializes not immediately but over time and is therefore easily overlooked by incumbents. It is a process that arises from a too narrow focus on so-called *sustainable innovations*. Hence, an understanding of innovations and their disruptive or sustaining characteristics is required in order for strategically optimal decisions to be made (Christensen et al, 2015).

Christensen (1997) expresses sustainable innovation as continuous development in performance of existing technologies and clarifies that most innovation is of that nature, products that increase in its perceived value according to the incumbent's current customers without significantly affecting the existing market. Sustaining innovation could be either evolutionary in the sense that it is expected, or revolutionary in a more unexpected way. Such an innovation could impose great threats to other incumbents, motivating them to respond. It could be a product or service that is cheaper or more simple for customers to use than previous solutions. Christensen et al. (2015) mention Uber as a service with several elements containing sustaining characteristics, helping customers in a more suitable way and therefore forcing their competitors to try and meet their offerings. For competition mainly concerning products, innovation is often understood as sustainable innovation, how-

ever when competition is such that the business models are redefined, Christensen et al. (2015) argue it to be more disruptive in its nature, similarly to the case of Uber.

The managerial rationale with sustainable innovations also lies in its less complicated development compared to disruptive ones. However, such innovations can not proceed forever without overshooting the current customer demands. *Technology overshooting* is often used as a part in the definition of disruptive innovation and refers to a situation when the technology overshoots the market need, as illustrated in Figure 2.1. In that context, an opportunity emerges for smaller companies which then are able to construct their competitive weapon in Christensen's (1997) disruptive technologies. It could mean that a product that is cheaper, more flexible or as in the example of Kodak and digital cameras; has another dimension of functionality, could win in the long run with a focus on just being good enough in all other dimensions (Grant, 2019). Such development enables market capture when incumbent firms' technologies, similar to Kodak's, overshoot the current demands as a result of sustainable innovation, existing customers' demands, Moore's law and realized potential in substitutes (Christensen, 1997; Grant, 2019).

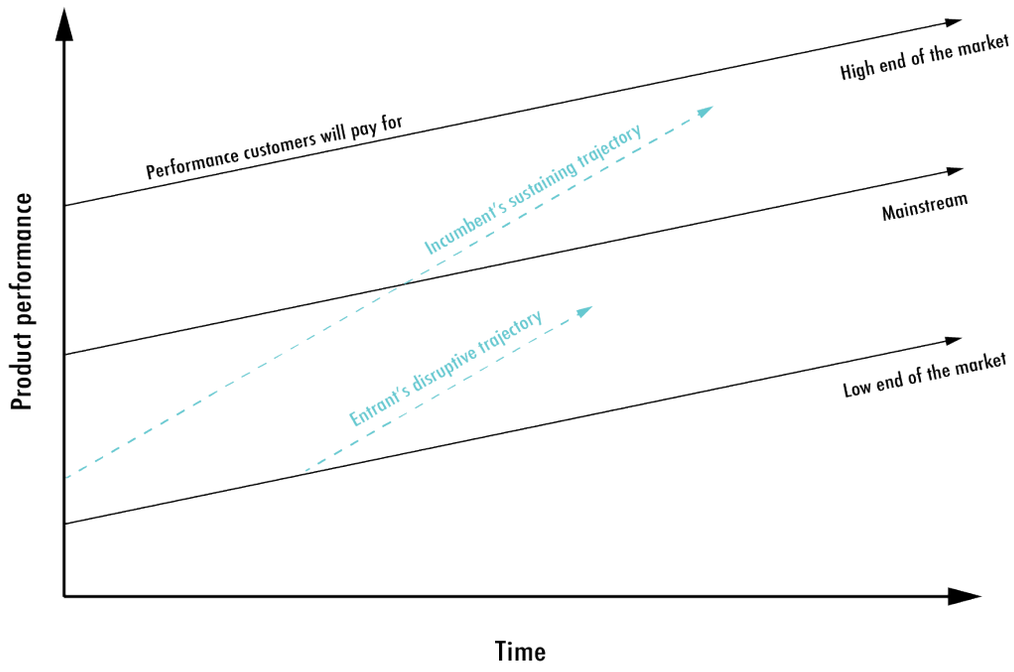

Figure 2.1: Technology overshooting as illustrated by Christensen et al. (2015).

With an understanding of disruptive innovation as a process that takes time and that it concerns entire markets and often business models, Christensen et al. (2015) further construct an idea that the appearance of disruption is coming from either *low-end* or *new-market* footholds. Low-end foothold refers to a market which incumbents do not focus on due to its less attractive revenue stream, and indicates a potentially easily accessible market with customers eager to switch for lower price and complexity. The new-market foothold stresses the potential in finding ways to

convert nonconsumers into consumers. It is suggested to acknowledge and utilize these two footholds before going further into the mainstream market, similar to how Netflix started out by appealing to the low-end customers and nowadays the Blockbuster customers (Christensen et al., 2015).

2.2 Technology Life Cycle

Kaplan and Tripsas (2008) illustrate the technology life cycle as a cyclical model seen in Figure 2.2. The cycle starts with a technological discontinuity, i.e. a breakthrough innovation that affects existing products or services. Further on, the era of ferment is reached, which Van Der Velden, Nasiri, Noorderhaven and Akkermans (2019) describe as a phase in the beginning of an innovation S-Curve, where a dominant design has not been established, which is defined by Utterback, Suarez and Fernando (1993) as "*a specific path along a design hierarchy*". Here, competition is fierce and focus is on research and development. Once a dominant design has been established, an era of incremental changes to the innovation occurs and eventually a new technological discontinuity emerges and the cycle starts over again (Taylor & Taylor, 2012).

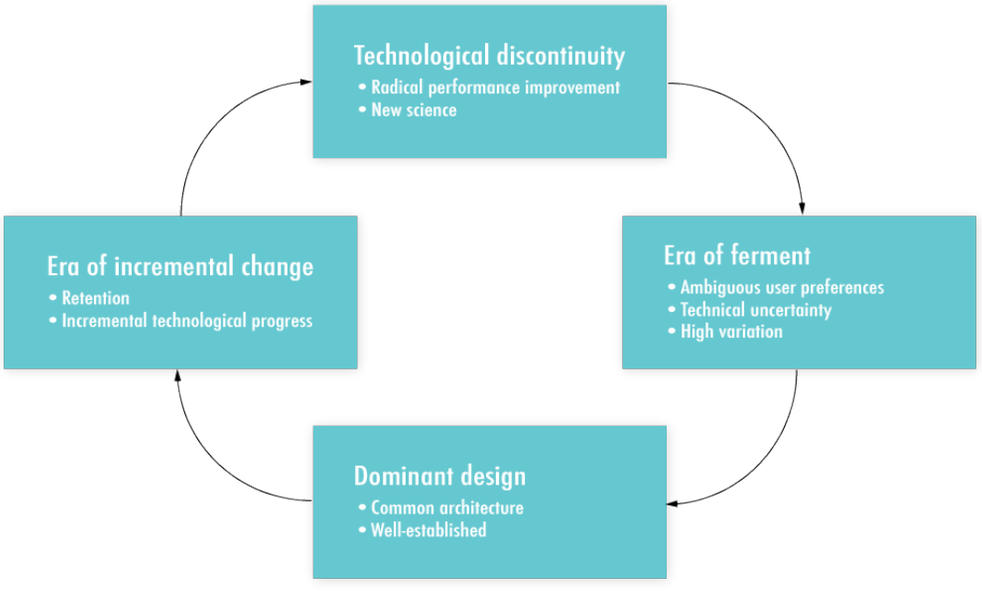

Figure 2.2: Kaplan and Tripsas' (2008) illustration of the technology life cycle as a cyclical model.

Utterback (1994) describes the relationship between the rate of major innovation and time with regards to both products and processes as a reflection of the technology life cycle. The model describes three different phases; *fluid phase*, *transitional phase* and *specific phase*. As seen in Figure 2.3, the rate of product innovation is higher compared to the rate of process innovation in the fluid phase. During this phase, competitors tend to experiment intensely with product design and operational characteristics since there are no certain requirements from customers. The fluid phase

is often associated with a technological discontinuity, a breakthrough innovation, meaning that products and processes of existing technologies are challenged (Taylor & Taylor, 2012).

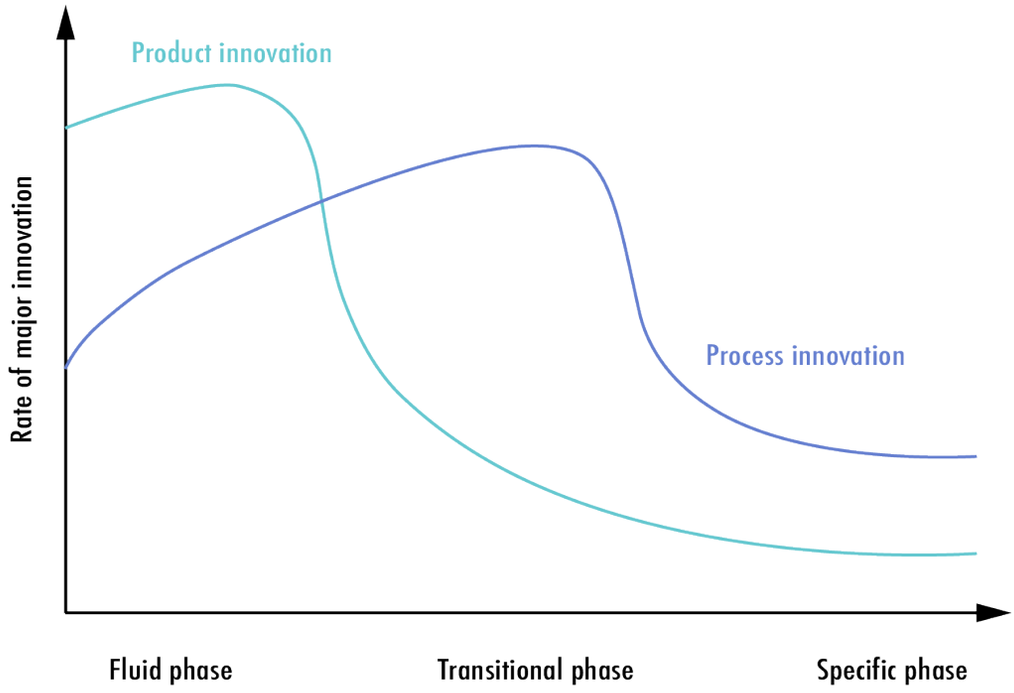

Figure 2.3: Utterback's (1994) 'Dynamics of Innovation' model, reflecting the technology life cycle.

Utterback (1994) mentions how the fluid phase gives way to a transitional one where the rate of product innovation slows down since the returns from product innovation are related to the acquisition of new customers according to Adner and Levinthal (2001). They further mention that as technology matures, innovative companies become more prone to invest in process innovation. Further, the emergence of a dominant design may take place, emphasizing how a product's design path dominates competing designs and becomes standard within the industry, leading to less entries from new actors (Utterback et al., 1993). Utterback et al. (1993) mention that a firm's chance of survival might be dependent on whether they enter an industry before or after a dominant design emerges, indicating that an entrance afterwards may significantly worsen the odds. Entering the specific phase, the rates of both product and process innovation are low and focus is being put on existing processes with often small, incremental improvements (Anderson & Tushman, 1990). The market becomes more stabilized and the more mature a technology becomes, opportunities for new emerging technologies open up (Taylor & Taylor, 2012).

Foster (1986) argues that a technology's progression moves slowly initially, then accelerates and eventually declines, indicating an S-curve shape as in Figure 2.4. Taylor and Taylor (2012) conclude that there are many different approaches for plotting the S-curve. For instance, Foster (1986) argues for technology performance

over time, whereas Adner (2004) mentions another variant called the *demand S-curve*, where customers' willingness to pay for the increased performance is plotted over time. By comparing the demand S-curve with Foster's (1986), managers may be able to identify which of the two curves are about to flatten first, hence being able to make optimal decisions depending on the situation (Adner, 2004).

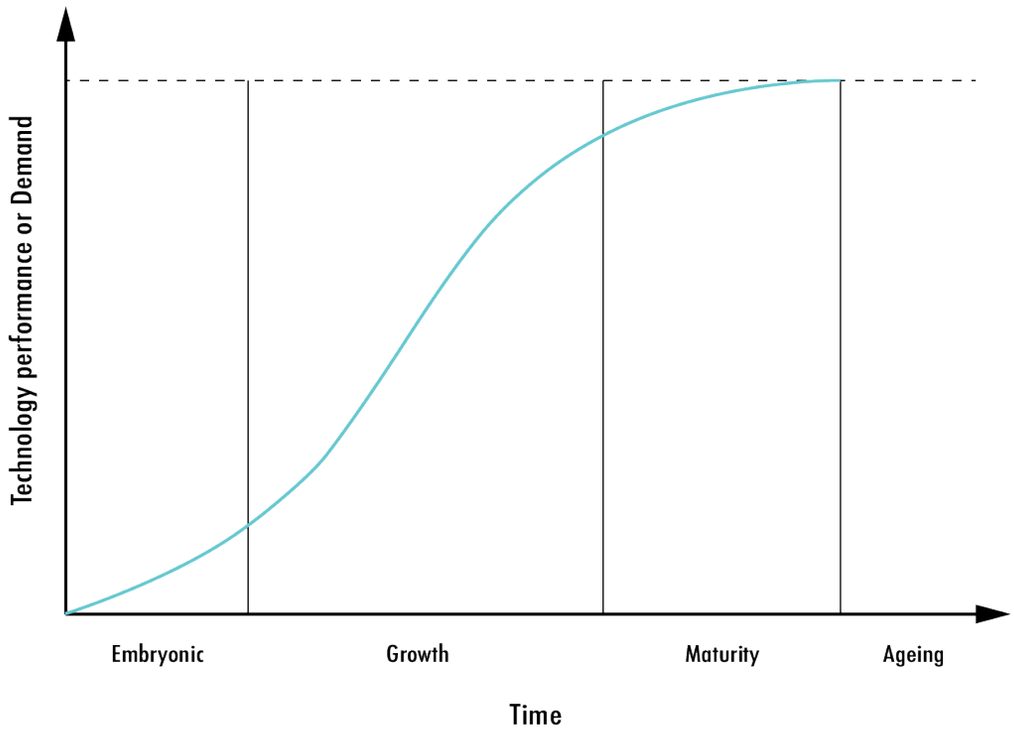

Figure 2.4: An S-curve as described by Foster (1986) and Adner (2004).

Taylor and Taylor (2012) emphasize how important it is for managers to evaluate in which phase their industry is in order for them to make optimal decisions. This can be in terms of what companies they should collaborate with or acquire. It can also be important in terms of how the company should frame their marketing strategy. Ford and Ryan (1981) emphasize the understanding of the life cycle while considering the perspective of the technology developer, and also argue that it is of importance to understand the stages of the life cycle and to realize how different stages demand different strategies in order to make more informed and therefore better decisions. Taylor and Taylor (2012) claim that their interpretation of the technology life cycle differs from previous interpretations since they are taking the technology as the unit of analysis instead of a product-based approach. In addition, they involve the entities *application*, *paradigms* and *generations* plotted against time and granularity according to Figure 2.5. Application refers to what the technology in question will achieve, whereas paradigms stretch over longer periods of time, and during that time several generations of the technology occur.

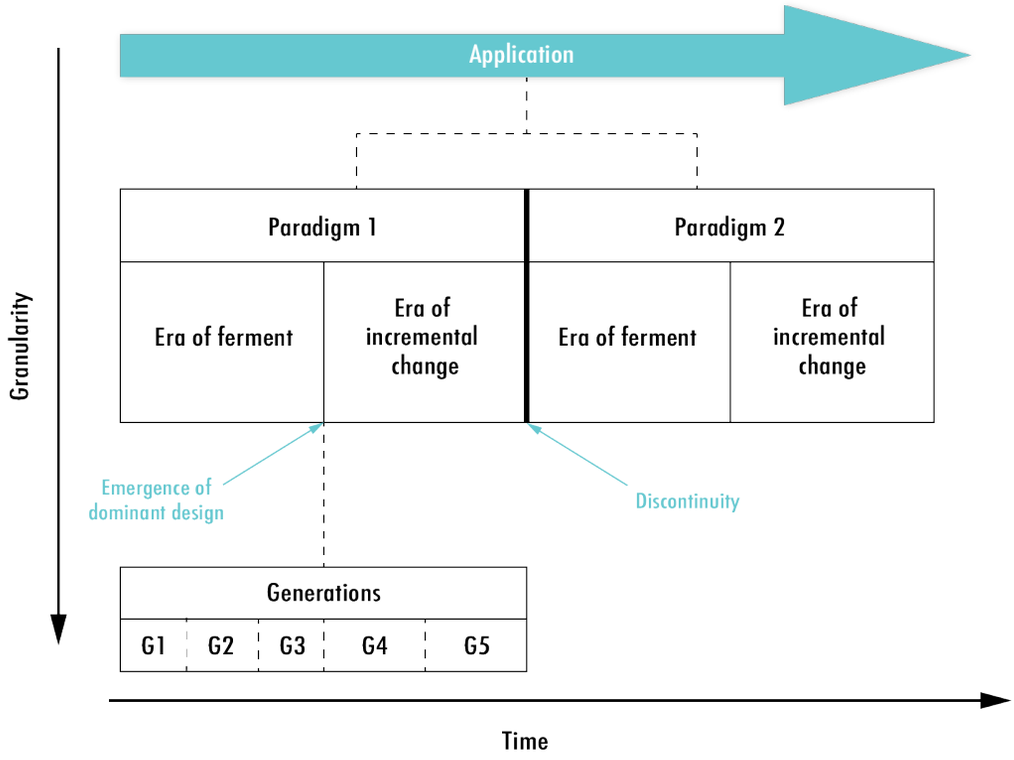

Figure 2.5: Taylor and Taylor's (2012) conceptualization of the technology life cycle incorporating application, paradigms and generations.

2.3 Diffusion

Rogers (1962) defines diffusion as "*the process by which an innovation is communicated through certain channels over time among the members of a social system*". *Adoption*, which is part of the diffusion process, is referred to as the decision to use and implement a new idea. The adoption over time as initially defined by Rogers (1962) is a normal distribution curve that represents the rate of adoption. The curve, illustrated in the bottom of Figure 2.6, can be divided into five blocks where each block represents a group in society. These groups have different desires to adopt a new technology and risk aversions towards it (Sahin, 2006). Rogers (2003) classifies these groups as *innovators*, *early adopters*, *early majority*, *late majority* and *laggards*.

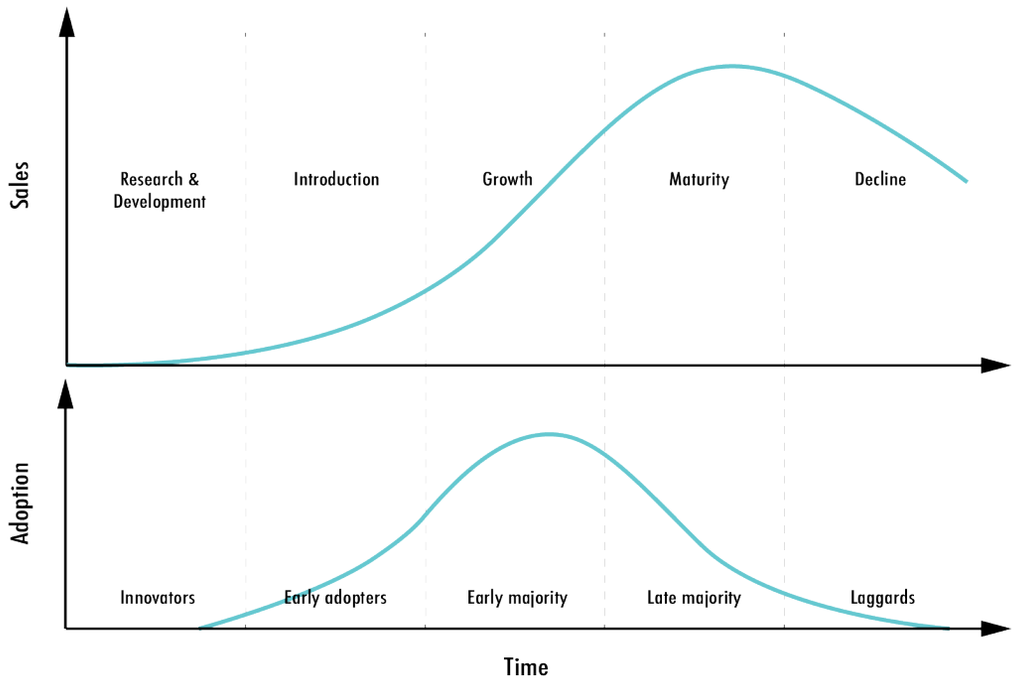

Figure 2.6: Rogers' (2003) technology adoption curve in relation to sales over time.

The rate of adoption among the aforementioned societal groups can be plotted in relation to how sales are affected over time, illustrated in Figure 2.6. In order to reach growth and maturity, a technology must reach a major part of the users, consisting of the early majority and late majority, respectively. The first phase is linked to large investments in research and development in order to come up with and produce new technologies. When entering the introduction phase, focus is being placed on generating awareness about the new technology, hence paving the way for an increase in market shares in the upcoming growth phase. Further on, when a rate of maturity has been reached, competition becomes more fierce and modifications of products and services are crucial in order to retain market shares. Eventually, market saturation will begin and companies must reevaluate their product strategies (Orcik, Tekic & Anisic, 2012).

Moore (1991) mentions a critical step for new technologies; reaching the growth phase and the early majority. He coins the concept of *crossing the chasm*, referring to the gap between the groups of early adopters and the early majority and explains that this will determine whether a technology will be moderately or extremely successful. The author argues that the gap exists since the early majority does not accept faults and incomplete features to the same degree as the early adopters would. In order to cross the chasm, Moore (1991) mentions that companies need to:

- have a complete product without incomplete features,
- position the product right and take the early majority's pragmatism into consideration,
- use competitive pricing rather than value-based pricing and
- use the right distribution channels.

The early adopters play a crucial role in the adoption process according to Sahin (2006), explaining that they secure the continuous adoption of the new technology. By signaling to the rest of the society that an innovation is approved, early adopters may reduce the uncertainty of adopting (Rogers, 2003). In order to conquer a small market section, which then can turn into a stronghold prior to an advance into the broader market, Moore (1991) introduced *the beachhead strategy* which implies targeting a specific group of customers based on certain characteristics. This customer group is then identified as the early adopters. Nonetheless, this may be considered a difficult task due to the requirements of understanding the customers beforehand. Rogers (1962) discusses degrees of opinion leadership, and argues that the early adopters have the highest one, inferring that this group is key not only to be able to cross the chasm, but also to steer future diffusion of the innovation in question.

With an underlying argument that diffusion is a process in which an innovation is communicated over time within certain channels and members in a social system, Rogers (1962) defines four main elements in the diffusion of innovations; *innovation*, *communication channels*, *time* and *social systems*. He describes how the defined boundaries of an innovation creates problems for practitioners, and uses five characteristics of innovations in order to explain different rates of adoption due to the innovation itself; *relative advantage*, *compatibility*, *complexity*, *trialability* and *observability*. Relative advantage should be understood as the perceived and subjective value, and could be of both economic and social nature. Compatibility refers to the degree of which an innovation is compatible with previous norms, experiences and needs, meaning that the innovation does not require prior adoption of other innovations or values. Complexity refers to the degree of which an innovation is perceived as difficult to use and understand, meanwhile trialability describes how easy users can try the innovation and decrease the uncertainty as a way of adopting it more quickly. Observability refers to the degree to which an innovation's results are easily observed, enabling better opportunities for discussions and word-of-mouth diffusion (Rogers, 1983).

In order for innovations to diffuse, communication between different individuals must take place. The essence of diffusion is the interchange of information between the different actors, consisting of an idea that is new to one or several actors, shared through a certain communication channel. The outcome of the communication, the information-exchange process, is determined by the existing actor-relationship, the medium and the nature of the innovation itself. Rogers (1983) explains that groups of individuals with a high degree of homophily, i.e. individuals that are similar in certain attributes, tend to have more efficient communication. However, some degree of heterophily, i.e. the opposite of homophily, is necessary in order for innovations to diffuse. The five adopter categories in Figure 2.6 illustrate these concepts and in order for further diffusion to take place, communication between the different groups must occur (Rogers, 1983).

Rogers (2003) defines a social system as "*a set of interrelated units engaged in joint problem solving to accomplish a common goal*". Since diffusion of innovations

takes place in a social system, it is influenced by the social structure of that system, which Rogers (2003) describes as "*the patterned arrangements of the units in a system*". He further claims that the nature of the social system affects individuals' innovativeness, which is the main criteria for categorizing adopters. Chau and Hui (1998) further emphasize that early adopters tend to be of an opinion leadership style, desiring novel information and having previous experience within the area when analyzing diffusion for new IT products. Grewal, Mehta and Kardes (2000) further discuss how social identity affects opinion leadership and customer innovativeness. They argue that this attitude generates a higher degree of innovativeness, hence a higher rate of adoption, especially in cases where the innovation is publicly consumed rather than privately. The social identity therefore influences behaviour in the early adopter as well as helping an innovation to diffuse amongst its later adopters.

3
Method

The following chapter describes the methodology chosen and the reasoning behind it by presenting the research approach, research process and finally a section considering the research quality.

3.1 Research Approach

In the quest for efficient business research, Bryman and Bell (2015) put emphasis on the need for a research strategy. Such a strategy should offer high-level guidance to the author in the process of planning, executing and monitoring, while the research methods formulate how to gather and process data (Johannesson & Perjons, 2014). This study has its formulated research questions concerning a technology's characteristics in general and a company's strategy in particular. It goes in line with what Saunders, Lewis and Thornhill (2012) defined as suitable for a qualitative research strategy, with data that is non-measurable, yet observable. Therefore, this study follows a qualitative research strategy. Furthermore, Easterby-Smith, Thorpe and Jackson (2015) declare how a constructionist approach suggestively involves qualitative research and that the emphasis on several existing truths enables a more nuanced understanding of the research. A constructionist's ontological position explains that the reality, or aspects of it, is socially constructed as a result of interpersonal interaction and collective actions. Applied to this study on disruptiveness, adoption- and diffusion processes, the researchers emphasize the constructionist's ontological position and follow methods thereafter.

Bryman and Bell (2015) clarify how qualitative research often is conducted according to one out of five designs; *experimental*, *cross-sectional*, *longitudinal*, *case study* and *comparative*. They further describe how qualitative research often suits well with case studies since it regards the complexity and nature of the chosen case, similar to how Mixtive's work on the chosen market of AR is investigated. In order to answer these research questions in a clear manner, a case study is conducted and the presented results are further split up into four parts. Firstly, a definition of AR as a technology and its current state is described. Secondly, results from the interviews regarding current needs and issues that companies experience within communication and collaboration are presented. Thirdly, potential applications for AR and its barriers are brought up, whereas the last part of the case study's results account for Mixtive's current product AR Call.

Bryman and Bell (2015) further describe how theory is integrated in research, and differentiates between studies characterized by a deductive and an inductive approach. A deductive approach implies a process in which logical conclusions are drawn from given premises, meanwhile an inductive approach means that general statements are proposed based upon specific cases. This study follows an abductive reasoning, a combination of deductive and inductive logics with both applied theory and empirical data, allowing for an exploratory case study with great depth, yet seeking conclusions that apply to a more general context than the study's one (Patel & Davidson, 2015).

3.2 Research Process

The research and entire study's process is illustrated in Figure 3.1 below. As the first two parts, the study's scope and research approach as well as design were considered, whereby the larger phases with data collection and analysis follows, which also is further described below.

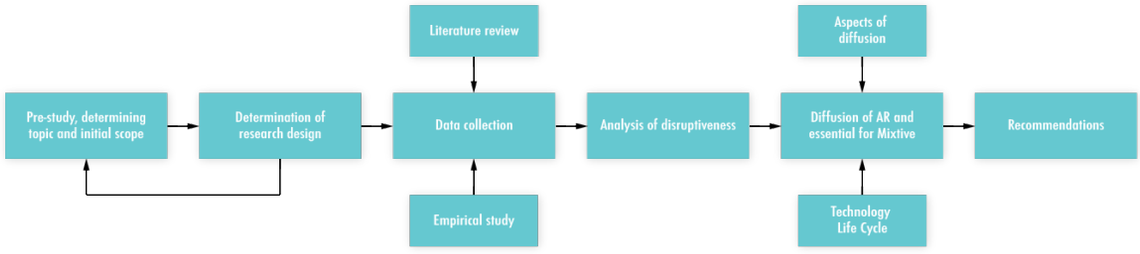

Figure 3.1: Illustration of the study's process.

3.2.1 Data Collection

The collected data for this study was both primary and secondary data. Primary data used in this study originates from the interviews and was collected directly from the data source itself (Bryman & Bell, 2015), meanwhile secondary data have already been collected through primary sources and is accessible for researchers to include, similar to the data for this study used in the literature review as well as the AR chapter.

3.2.1.1 Method For Literature Review

In order to collect and present the theory used in the analysis, a literature review was conducted. Easterby-Smith et al. (2015) argue that in a literature review, researchers describe, evaluate and clarify what is already known about the topic. This also highlights the need for the authors to further learn about the technology and its context. The difficulties in doing such a review lie in the challenge of determining what information is trustworthy and relevant to the study (Eriksson & Wiedersheim-Paul, 2014). This is emphasized in this study due to the vast amounts of data that exists from previous research within disruption and diffusion, as well as the hype around the technology.

The literature review was based on a number of key articles from within the field of management and economics of innovation that helped form the basis of literature search. Identified keywords were then used for searches in databases such as ResearchGate, Retriever and Google Scholar in order to obtain further specific information in an optimal way. When relevant literature was identified, so-called chain searches were then conducted in order to collect further information on the topic (Ejvegård, 2003).

3.2.1.2 Method For Interviews

The study comprises several interviews, all of which were conducted in order to bring depth to the study and a deeper understanding of the technology, potential needs and lastly the market's potential. Eisenhardt (1989) defines in the process of theory building how multiple perspectives, data collection methods, as well as investigators help nuance the case study. In this study, with limited investigators and data collection methods, a broad range of observations is desired, despite the ambition of helping Mixtive on a specific market. Therefore, a blend of positions as well as experiences were sought for within the interviewees. All are working professionals, and a clear majority within areas assumed to see a strong potential in Mixtive's technology, e.g. the sales company GoSales. Besides professionals in other fields such as product development, interviews were conducted with specialists within the field of AR and research related theory, as well as developers at Mixtive in order to create a better understanding of the product AR Call. The interviewees and their area of business are presented in Table 3.1 below.

The interviewees were chosen based on two principles; *criterion sampling* and *snowball sampling*. Criterion sampling suggests that the interviewees are chosen based on their experience in relation to a number of criterias (Bryman, 2002). In this case, representatives with insights in the technology, its potential and application, as well as product- or sales-oriented companies that could exploit the technology. A conducted snowball sampling means that several interviewees were approached through, and by, previous interviewees. A key informant was Christian Rosengren at Siemens, providing valuable interviewees.

All interviews were of semi-structured form. This technique for conducting interviews was arguably the most suitable due to the fact that most interviewees only were approachable once (Bernard, 2006). The questions, as listed in Appendix A, were formed open-ended in order to enable further follow-up questions when more in-depth discussions were substantial, allowing for a predetermined flexibility. Easterby-Smith et al. (2015) clarify that the combination of a predetermined structure, yet freedom in followthrough, helps reach deeper understandings from the interviewees. Also, the interviews were opened in a way that the interviewees did not know about the specific focus on remote collaboration and communication with AR, and in some cases not about the authors cooperation with Mixtive. This follows the methodology Fitzpatrick (2014) defines in his book *The Mom Test*, implying a focus on the interviewees' lives and issues rather than the business idea itself.

Name	**Title**	**Company**	**Product/service & industry**
Anders Baer	Product Development Manager	Telia Company	Tele-communications
Anders Welander	CEO	GoSales	Sales, all sectors
Annelill Annvik	CEO	Gafs Kartong	Product development, Packaging
Christian Josefsson	CEO	Uptive	Fullstack and UX development, all sectors
Christian Rosengren	Sales Executive	Siemens	Digital Industries Software, IT
Engin Hassamanci	Senior Industrial Designer	Farm Product Development (Farm PD)	Product Development, Healthcare
Filip Fatic	Software Developer	Mixtive, AR Call	AR and VR, IT
Fredrik Löfgren	CEO	Around the corner	Communication services, Virtual Reality
Göran Solback	Digital Enterprise Sales	Dassault Systemes	3D software, IT
Jenny Arnesson	Global Workflow Consultant	Ascom Wireless Solutions	ICT, Healthcare
Johan Nordling	Pre Sales Account Development Team Lead	Siemens	Digital Industries Software, IT
Johan Norrman	Director R&D Platforms	Ascom Wireless Solutions	ICT, Healthcare
Johannes Palm	Sales Manager	Awake	Product Development, Electric Surfboards
Magnus Willner	Founder CEO	Mixtive	AR and VR, IT
Marcus Holgersson	Associate Professor	Chalmers University of Technology	Entrepreneurship & Strategy, Academia
Peter Hedihn	Production Manager	Ullman Dynamics	Product Development, Suspension seats
Stefan Johansson	Purchase Manager	aPak	Product development, Packaging

Table 3.1: The interviewees by name, title, company and product/service & industry

3.2.2 Data Analysis

The first step of the data analysis is combining the two different data collections, primary data from interviews and secondary data from the literature review. The goal is to seek an understanding of AR and its potential disruptiveness, as well as its current contextual environment, potential and barriers. Combining these aspects in the analysis, and potentially reaching a consensus, helps the authors answer the first research question regarding the statement that AR could be a disruptive technology. With such understanding, a secondary analysis of the work at Mixtive regarding the product AR Call is conducted, with emphasis put on building a strategy based on the knowledge about AR and its different aspects relevant for adoption and diffusion.

Bryman and Bell (2015) explain how data derived from interviews often is unstructured and difficult to analyze, which is further asserted by the way the interviews were semi-structured with open-ended questions and an allowance for flexibility. Consequently, a method for data analysis was chosen that allowed for continuous analysis throughout the period of data collection; *grounded theory*. Strauss and Corbin (1998) define it as a method where data collection, analysis and eventual theory are closely related to each other, with the purpose of developing theory from the data in an iterative manner. Bryman and Bell (2015) mention two key concepts in grounded theory; *coding* and *constant comparison*. Coding refers to the central process where data is broken down into components whereas constant comparison refers to the focus on maintaining a close relation between the data collection and the conceptualization, emphasizing a broad perspective within each codified category while seeking to create categorical theories. When coding the data in this study, a utilization of so-called open coding and to some extent thematic coding were made. It means that relevant themes regarding the research questions were chosen and processed into the interview structure (Dalen, 2015). Themes were to some extent chosen beforehand, based on certain understandings for the interviewee's industry. In order for maximum clarification, not only were the data analyzed through the use of such coding and thematic analysis, but it is also the way in which the data is presented in the empirical results.

3.3 Research Quality

Bryman and Bell (2015) shed light on the three most prominent factors for evaluating business research; *reliability*, *validity*, and *replicability*. However, as Bryman and Bell (2015) explain, understanding a research's replicability is rather similar to reliability, yet not as valuable for qualitative research as in quantitative such. Therefore, replicability is not further emphasized or analyzed, meanwhile validity and reliability are described and applied below.

3.3.1 Validity

Bryman and Bell (2015) explain how validity describes whether the chosen research method and design are appropriate for the research's desired outcomes. A

valid study therefore means that the chosen research design is relevant to the research methodology, the methodology appropriate for the research question and the research questions themselves appropriate in order to reach the desired goals. LeCompte and Goetz (1982) further illustrate how validity can be separated into external validity describing how well a study can be generalized to external settings as well as into internal validity, emphasizing how well the researchers observations and theoretical ideas align. Due to the difficulties in assessing external as well as internal validity in qualitative research, Guba and Lincoln (1994) further rephrase an expression for evaluating qualitative research quality; *trustworthiness*. They define trustworthiness with the help of transferability, as a similar criterion to external validity, and credibility as a criterion for internal validity put in the context of research that is conducted in social contexts where absolute truths are assumed not to exist. Since this study follows a constructionists approach, the key for appraising its validity is its transferability and credibility according to Guba and Lincoln (1994).

Just like Bryman and Bell (2015) assess qualitative research in general, this study is rather difficult to appraise a high level of validity. Seeking high validity, without being able to call a study *valid*, a broad range of perspectives were searched for, including both the literature review and the interviews. The interviews also covered a wide range of perspectives, with employees in different contexts with various experiences and positions, but all relevant for the study and Mixtive's sought understanding. However, as always, it is impossible to say that the data reflects the reality, especially in such an area as AR where information is rapidly changing, making it difficult to assess whether an article, theory or application is up-to-date or not.

3.3.2 Reliability

Eriksson and Wiedersheim-Paul (2014) defines reliability as the likelihood of concluding the same results in a replicated study. LeCompte and Goetz (1982) defines, similar to the parts of validity, how reliability can be achieved externally as well as internally. External reliability emphasizes the potential in replication and is clearly a difficulty in qualitative research, which they argue depends on the inability of pausing a social setting, experience or circumstances affecting the study's results. Furthermore, they explain how internal reliability declares whether the research team agrees on the perceptions on what they see and hear. Again, Guba and Lincoln (1994) argue that reliability is more difficult to appraise in qualitative research and therefore again address trustworthiness as a key criterion for quality, and regarding reliability they emphasize dependability as the key dimension of analysis. Dependability basically questions whether the findings are likely to apply at other times.

In the strive for quality and a certain degree of reliability, the interviews played a central role. Mack, Woodsong, Macqueen, Guest and Namey (2005) describe how recorded interviews potentially can make interviewees uncomfortable, and in combination with all interviews conducted as a pair of interviewers as well as content-

checks for delivered data from the interviewees, it was chosen not to record. Furthermore, Mack et al. (2005) discuss how leading questions lead to biased answers, similar to how Fitzpatrick (2014) points out that focus should not be on the idea that you have if you wish to understand a potential customer fit. As an example, with guidance from Fitzpatrick (2014), interviewees were often asked if it was something else that should have been touched upon in order to expand the discussion. Again, as Fitzpatrick (2014) advices, interviewees were often told to guide the authors through processes and specifics in the past, this in order for the interviewee to discuss topics of relevance, for example with the frequently asked open-ended question "*how does your product workflow, from design to delivery, look like today?*". This was on one part due to the goal of achieving maximum transparency and unbiasedness, but also in order to understand complete workflows and see opportunities for AR which the interviewees did not see.

3.3.3 Methodology Reflection

Not seldomly, a combination of both quantitative and qualitative research is considered optimal. Since the area of AR is rather new and unexplored, it is difficult to find any statistical correlations, hence important to combine the research with qualitative research. Applied resources on the technology are mainly gathered from blog posts, articles and similar, thus creating an increased subjectivity. It may also be questionable why the technology was not highlighted even further, perhaps through interviews with experts and other companies within the field. However, this was because of the study's scope primarily focusing on the demand side and thus on potential applications, users and customers, with the ultimate goal of guiding Mixtive on the market rather than on the technology. All in all, helping Mixtive to change perspective technology- to customer-driven.

The study was conducted during the spring of 2021 with the Covid-19 pandemic still ongoing, hence social distancing and travel restrictions were in place. Therefore, all interviews were held digitally, which could sometimes affect the quality of the conversations, for instance when an interviewee would demonstrate certain content via screen sharing. The interviews were decided not to be recorded, with the underlying argument being that interviewees could elaborate on their thoughts and discuss more in detail. In retrospect, recordings could have been valuable in certain cases, but with what turned out to be great relationships with the interviewees, possibilities for follow-up questions and further clarifications resulted in it not being considered a problem throughout the study. Also, given that the area of AR is very broad and the industry rather unclear, a majority of the questions were of an open-ended nature, which might indicate that some degree of interpretation from the authors were necessary in order to decode the qualitative data. Furthermore, one could question whether the interviewees could be considered representative as a whole, given that a snowball sample was used to some extent. Hence, some interviewees might be of the same opinion as the ones who recommended them. Despite a risk of the interviewees being rather homophilous, valuable insights were obtained from all, contributing to the study's cause.

4

Empirical Findings

This chapter presents the empirical findings split over four sections, firstly with a coverage on the technology based on gathered secondary data. Secondly, key take-aways from the interviews on the topic of business needs and current issues are declared, followed by a section on the potential applications of AR in the interviewees' contexts. Lastly, findings from the interviews regarding Mixtive and their work with the product AR Call is presented.

4.1 Augmented Reality

The following section contextualizes AR as a part of the umbrella term Extended Reality before more closely defining it together with a number of applications. Also, a clarification of the market with some forecasts, trends and future rumors is presented.

4.1.1 Extended Reality

The concepts of Augmented- and Virtual Reality are often considered to be closely related. Milgram et al. (1994) first introduced the *reality-virtuality continuum* as seen in Figure 4.1 when explaining the relationship between the real- and virtual environment. The left end represents an environment where all objects are real and can be viewed directly in person or via a display. In contrast, the right end represents a scenario where all objects are virtual and include simulations that are monitor-based or immersive. In addition, Milgram et al. (1994) introduce the term Mixed Reality (MR) which represents the area in between the two extreme end-points, where both real and virtual objects exist simultaneously and interact with each other. According to Milgram et al. (1994), Augmented reality falls under the MR-category and involves digital content that enhances the real environment (Migram et al., 1994).

Figure 4.1: Reality-Virtuality Continuum from Milgram et al. (1994).

Since Milgram's publication in 1994, the definitions and explanations of MR are many. Microsoft has tried to monopolize the term by introducing the platform "Microsoft Mixed Reality", which in reality refers to VR applications. Hence, some consider the term to be rather misleading and confusing. The swedish knowledge platform Immersivt, specialized in immersive technologies, considers the umbrella term Extended Reality (XR) to be more intuitive as illustrated in Figure 4.2, encapsulating both AR and VR (Johansson, 2018).

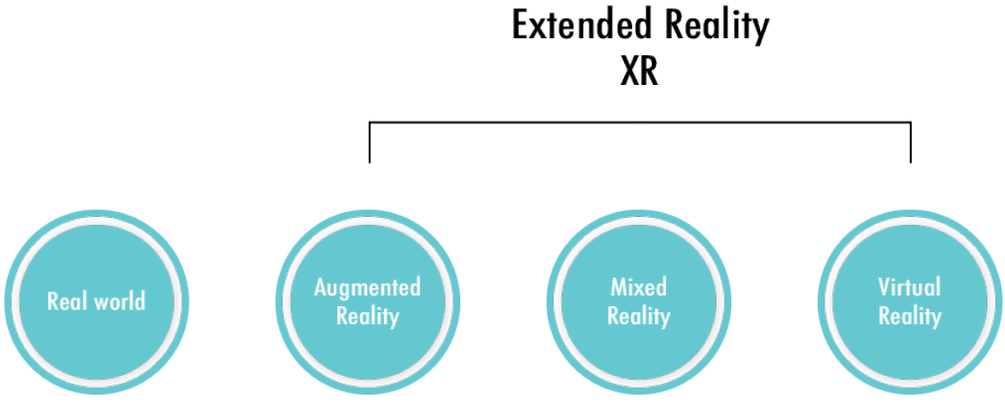

Figure 4.2: Extended Reality and the included parts as described by Johansson (2018).

4.1.2 Definition of Augmented Reality

The definitions of Augmented Reality (AR) are many but similar. Peddie (2017) defines AR as a technology that superimposes digital content on a user's view of the real world, and Greenwold (2003) as a technology that calls upon the virtual to annotate the real. It adds digital information such as images, audio and video that users can interact with in the same way as one could with the physical world (Craig (2013); Kipper, Greg & Rampola (2012)). The history of the technology goes back to the 1960's when Harvard professor Ivan Sutherland created the first head-mounted display, but it wasn't until in the 1990's that the term Augmented Reality was coined (Poetker, 2019). According to Craig (2013), the main objective of AR is to "*provide stimuli to cause the participants to believe that something is occurring that really is not*".

For an AR experience to be possible, some key factors need to be present (Craig, 2013):

- *AR Application*: a computer program that controls and displays a 3D-object so that it appears to present in the physical world. An example is Apple's Quick-Look software, which enables iPhone users to instantly launch AR experiences from a browser (Apple, 2021).
- *Content*: what is displayed and experienced within the application. This could be 3D-objects, animations, call-to-actions, and needs to be produced beforehand.
- *Interaction*: AR experiences include some interaction in one way or another. This usually includes seeing objects from different perspectives but also enabling actions such as rotating, scaling, and pressing.
- *Technology*: all AR experiences have a base level of technology. In order for the device to scan the environment a sensor is required, as well as some computation in order to place the object into the environment.
- *Physical world*: by definition, an AR experience is always taking place in the real world. It could either be at a specific place in the world, for instance decorating a certain building with digital content, or at a generic place where digital content can be visualized.
- *Participants*: participants have a key role in an AR experience since their actions and motions affect the experience directly.

AR is compatible with several hardware devices. First, there are handheld devices such as smartphones. During the last couple of years, Android and iOS phones have had the ability to run AR applications. They are becoming more and more powerful for every new release as manufacturers such as Apple invest heavily in the technology (Zade, 2020). There are also head-mounted displays, and a famous example is the Google Glass that was released in 2013. However, the product was not the success many hoped for, with a functionality way below what was expected from customers in combination with a substantial price tag (Bilton, 2015). Since then, several companies specialized in AR glasses have emerged with brands such as Nreal, Magic Leap and Hololens. AR-glasses are considered more powerful and useful than smartphones within e.g. different industries where operators need their hands to be free. Lastly, there is *Spatial Augmented Reality* (SAR), or *projection mapping*, where no handheld or head-mounted devices are used. SAR utilizes digital projectors to display graphical content on physical objects (Park, Lim, Seo, Jung & Lee, 2014).

Since companies like Apple and Google are investing heavily in AR technology, they have released and developed ARKit and ARCore respectively (Summerson, 2018), so called *Software Development Kits* (SDK), which Gartner (2021a) describes as "*A set of development utilities for writing software applications, usually associated with specific environments*". These utilities provide developers with tools to easier produce applications with the technology. There are mainly two types of AR when referring to the software; *marker* and *markerless* AR. Marker based AR is

dependent on a certain object in the physical world to work as a trigger or anchor in order for the experience to function properly. More recently, marker-less AR is available and uses localization technologies such as GPS in order to control the relative position between digital content and the physical world (Cheng & Chen, 2017). Furthermore, new technologies that are being included into hardware are opening up opportunities for AR. In 2020, Apple released their new iPhone 12 Pro with an equipped LiDAR sensor (Wilson, 2020). LiDAR technology uses laser scanners to provide accurate information about the environment (Gargoum & Karsten, 2021). It enables, in this case the iPhone, to further enhance the AR experience with more precise and smooth positioning of digital content into the physical world (Wilson, 2020). Combining this with 5G-technology, AR experiences can be provided with even more precise positional data, giving rise to AR experiences with extremely accurate environmental information (McDowell, 2020).

4.1.3 Applications

The applications of AR are many, where perhaps the most famous example is Nintendo's Pokemon Go game released in 2016. Users can walk up to Pokemons all over the world based on geolocation and interact with them in the game, while they are displayed in AR right in front of the users in their own environment (Lopez, 2016). Another common and relatable example is the use of filters in applications such as Snapchat and Instagram, where users can apply filters on their face in real time, as the app uses face recognition to apply the filter correctly (Jun Aw, 2020). Apart from entertainment, larger corporations are also using AR for other purposes. For instance, SJ uses AR in their app so that users can navigate easier while at the train station, receiving visual guidelines in their app, visualized on the station floor (SJ, 2018a). Another example is how Postnord allows their customers to visualize their awaited package in AR in their app in order for them to get a better understanding of the dimensions of the parcel (Wilhelmsson, 2017). One example regarding communication and collaboration is XM Reality, a company that provides AR solutions with remote guidance tools. For instance, electricians can, by the use of AR, guide users with tasks that otherwise would take longer time or even require them to be present physically at the location (XM Reality, 2020). Another widely used platform is Spatial, which is a cross-platform application that allows for communication and collaboration between users in both AR and VR. They provide tools for companies and individuals to interact with each other remotely, but still being able to feel the presence of each other (Spatial, 2021).

Figure 4.3: Person playing Pokémon Go (Gstoll, 2016).

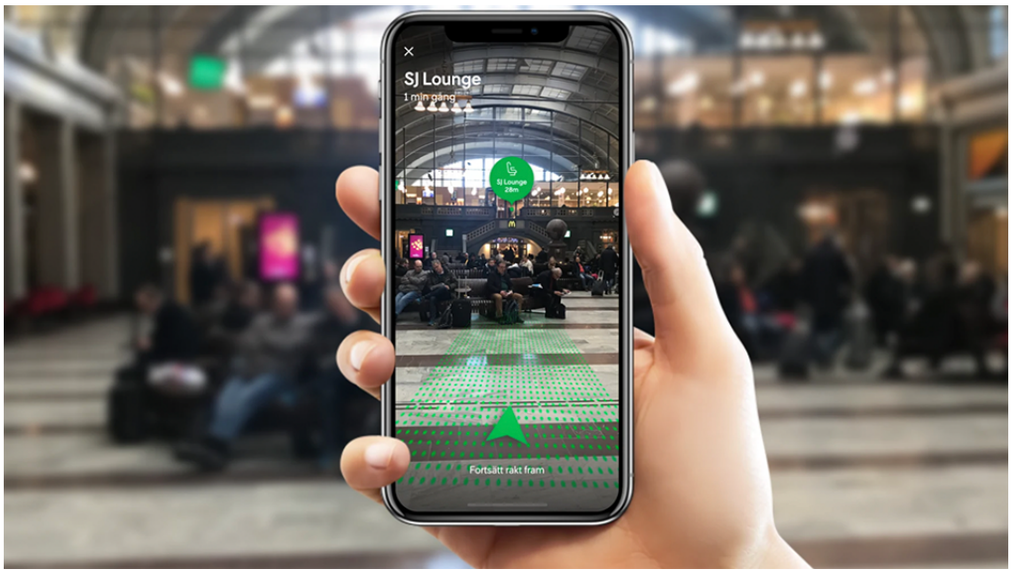

Figure 4.4: Person using SJ's AR-navigation app (SJ, 2018b).

4.1.4 Market and Forecasts

Augmented Reality and its related technologies within the XR continuum have had high expectations for quite some time but the future is still, according to many, bright in terms of numbers. PwC (2019) claims that AR and VR have the potential to add over $1.5 trillion to the global economy by 2030. According to Statista (2021), the total market size as of 2021 is approximately $30.7 billion and is expected to grow to a staggering $296.9 billion by 2024. Although, forecasts have turned out not to be that accurate. Statista (2018) forecasted the AR and VR market to have

a compound annual growth rate (CAGR) of 177 % up until the year of 2023. However, statistics show that the actual CAGR between 2018-2020 was around 63-77 % (Statista, 2018; Statista, 2020).

Hardware is becoming cheaper and more widely available to consumers, enabling for a broader usage of the technology. Also, companies like Apple and Google continuously develop new tools for developers in order for them to create more applications and find new usage areas. As the technology advances, the supply of applications will increase and the use of AR by businesses will increase rapidly (Deloitte, 2018). The Gartner Hype Cycle, a tool that managers can use to evaluate an emerging technology's position in our fast-moving, innovative world, illustrates the technology's maturity and adoption (Gartner, 2021b). See Figure 4.5 for the cycle with AR's journey illustrated. According to Herdina (2020), enthusiasts have since over a decade estimated AR to reach its maturity within 5-10 years. That estimate has constantly been renewed, and in the 2019 edition of the Gartner Hype Cycle, AR was suddenly removed. AR technology has evolved and is no longer classified as an emerging technology, and has moved from being a technology managers should monitor, to a technology that should be utilized (Herdina, 2020). Furthermore, the technology has also been raised as a potentially new *general purpose technology* according to Paul (2017). He argued to see the characteristics describing general purpose technologies that Bresnahan and Trajtenberg (1992) defined; pervasiveness with a spread to most sectors, inherent potential for technical improvements, as well as innovational complementarities, indicating that it drives further innovation.

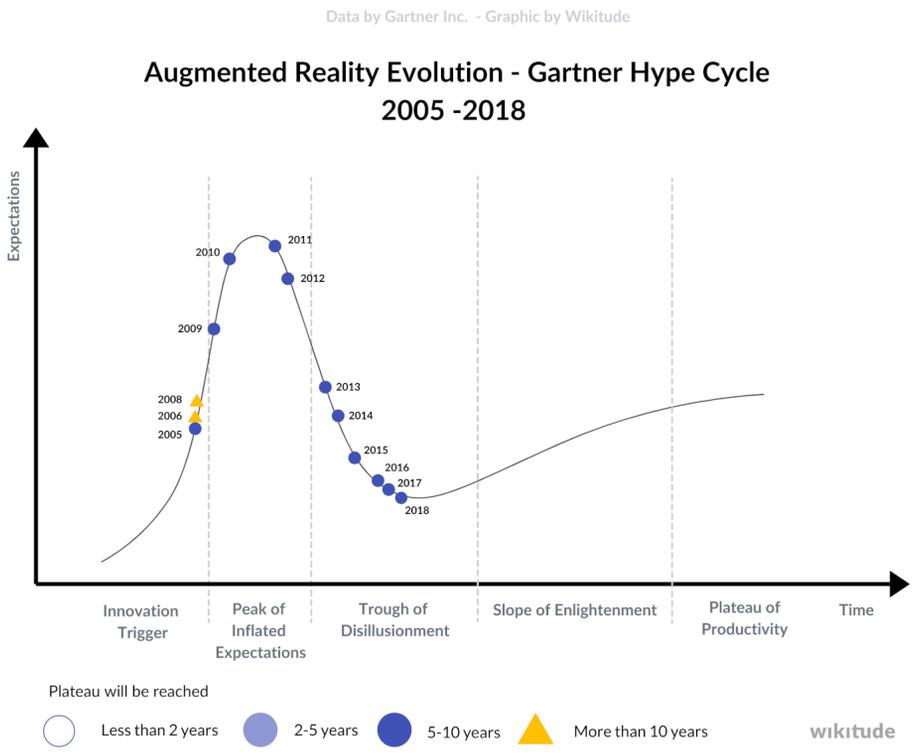

Figure 4.5: AR's evolution on the Gartner Hype Cycle (Herdina, 2020).

4.1.5 News and Trends

The development of AR and its related technologies is rapid. Huge investments are being made from corporations such as Facebook, which as of 2021 has almost 20 % of their personnel working on AR and VR (Byford, 2021). The Covid-19 pandemic has created an urge for companies to find new ways to communicate and interact with each other as social distancing and lockdowns have become common. As a result, opportunities for technologies like AR have opened up even further (Castellanos, 2021). In March of 2021, Microsoft announced their latest project, Microsoft Mesh, an AR based communication and collaboration platform (Langston, 2021). Apart from AR software, hardware is also developing at a rapid pace. AR glasses have been circulating for the last couple of years but have not yet been able to commercially succeed. Google Glass was first to honestly try in 2013, and since then many others have come. During 2021, several companies such as Facebook are expected to release their own version of AR glasses. The glasses most talked about are considered to be Apple's rumoured Apple Glass, which are predicted to be announced in late 2021 or early 2022 (Apple Insider, 2021). Due to the rapid development, ethical concerns are being raised as well. Many AR applications on the market use facial recognition, and some claim that these applications might be used to identify people in the streets, hence reducing the privacy of individuals (Blum, 2018).

With the development of software and hardware, AR is becoming more widely available for everyone to use. Before 2018, AR experiences in smartphones were only available in native applications. For the last two years, so-called web-based AR has been available, enabling users to launch AR applications directly from their smartphones' browsers which removes the requirement for companies to host an app in order to provide AR for their customers (Slotte, 2018). E-commerces across the globe have catched on the trend and e-commerce giant Shopify introduced the functionality of web-based AR on their platform in 2018 for all merchants on the platform (Beauchamp, 2018). Companies have also started to use AR for marketing purposes. For instance, fashion brand Gucci partnered with Snapchat in 2020 and released a function where users could try on virtual sneakers on their feet with AR (Hobbs, 2020), and energy drink company Redbull introduced an AR game for customers to play for a chance to win exclusive prizes (Games Press, 2021).

4.2 Business Needs and Current Issues

The following section presents a compilation of certain overlapping aspects on business needs and issues that were brought up by the interviewees and will therefore be presented sequentially. These are; *communication*, *simulations* and *collaboration*.

4.2.1 Communication

A majority of the interviewees mentioned a situation where their current solutions for communication are not sufficient. The telecommunication giant Telia Company experiences difficulties in communicating remotely, which has become far more promi-

nent during the Covid-19 pandemic. Anders Baer, Product Development Manager, described existing video meeting software as flat and basic, where additional features such as video filters are added frequently but are seen as "nice-to-have" rather than providing any additional value to the solution in question. Baer stressed the importance for organizations to have efficient and convenient communication solutions considering the ongoing situation where companies to a greater extent let their employees work from home. Fredrik Löfgren, CTO at Around the Corner, who specializes in hosting Extended Reality conferences for companies, concluded the same thing. Companies demand new, innovative solutions for working remotely, whether it is for team meetings, conference calls or a discussion around product prototypes.

Another area that came up was the healthcare sector when interviews were held with personnel from the information and communication technology company Ascom. They provide hospitals with high tech communication solutions that facilitate an easier workflow with better synchronization and less manual work. Despite these solutions being available, there are still issues regarding communication within healthcare that need to be taken care of. During the interview with Jenny Arnesson, Global Workflow Consultant at Ascom, issues with guidance during surgeries were lifted. There is a limit to how many people that can be in an operating room at the same time because of infection risks, meaning that surgical support from a distance would be highly beneficial, according to Arnesson. Apart from the regular procedures in for instance operating rooms, other needs have emerged during the Covid-19 pandemic, Arnesson continued. She meant that because of new procedures to decrease infection risks in hospital areas, hands free solutions for communication would truly make a difference for healthcare personnel. Johan Norrman, Director of R&D Platforms at Ascom, concurred with Arnesson's thoughts, claiming that there are endless needs within the healthcare sector concerning communication, but that Ascom can not pursue them all.

4.2.2 Simulations

The major tech companies Siemens and Dassault Systemes mentioned that their customers within manufacturing and heavy industries have over the years demanded far more advanced and automated solutions for their everyday business. Both Johan Nordling, team leader within pre-sales account development at Siemens, and Göran Solback, swedish sales manager for digital enterprises at Siemens, described a situation where simulations of so-called digital twins become more common in order for companies to more efficiently evaluate products and services. According to Magnus Willner, CEO at Mixtive, it aligns with the major project Mixtive engages in, Digital Twin City Centre (DTCC). It involves a complete digital twin over the city of Gothenburg, in which several stakeholders, whereas some are public, have seen great potential and now seek to establish the DTCC as the foundation for future digital planning, design, construction and management of sustainable, intelligent and inclusive cities.

4.2.3 Collaboration

During several of the interviews with product oriented companies, situations with far too many stakeholders involved in sales- and design processes were lifted. Peter Hedihn, product manager at product oriented company Ullman Dynamics, is well experienced in complex production and sales processes that involves both high quality assurances, international collaboration and multiple stakeholders. Hedihn described how these processes are challenging due to the requested quality controls and continuous communication involving several actors, and how it leads to bottlenecks for Ullman in their design and manufacturing processes, similar to what Hassanci mentioned as an issue for Farm PD. Both of them stressed the urge not just for efficient communication solutions, but also for the collaboration aspect. Farm PD designs complex medical equipment for customers all over the world. With an ongoing pandemic, sales personnel can not get access to operating rooms in order for them to evaluate how a specific product fits into the room or not. For this reason, Hassanci explained that they need tools that enable more flexible solutions that stimulate an even better synchronization between sellers and customers. He said that Farm PD "*have been experimenting with different collaboration tools where co-workers can co-create and evaluate 3D-models*". He further mentioned that designers and sales people would like to be able to interact with 3D-models in real-time together with manufacturers and customers in order to avoid any unnecessary miscommunications early on, hence reducing lead times.

Johannes Palm, sales manager of the innovative company Awake that sells electric surfboards, brought up similar issues like Hedihn and Hassanci with concerns regarding design and manufacturing. Apart from reducing lead times, Palm also mentioned the fact that sales people at Awake travel extensively for sales purposes when it in some cases could be more beneficial to conduct these sales meetings remotely with the right tools. He stressed the opportunity to achieve more efficient product development processes due to the saved time, but also to trim sales processes, engaging with leads early on in new ways. This goes in line with comments from Anders Welander, CEO of the sales consultancy GoSales, who emphasized the need for suitable tools for remote selling. However, he stressed that physical customer meetings still are crucial for success, but could benefit from a higher presence of technology supporting those processes. Welander further discussed how consumers are, and will be, expecting companies to enable better ways to visualise and try out products before completing purchases. Stefan Johansson, purchasing manager at aPak who delivers packaging solutions, was on the same line as Welander. He argued that involvement of customers is still important while finding new, flexible ways of conducting sales in order to reduce lead times. Still, they are in constant look and need for these solutions in order to stand out due to fierce competition within their industry of packaging.

Another actor in the same industry as aPak is Gafs Kartong, who designs and develops custom made packaging. While interviewing CEO Annelill Annvik, she also talked about how they would like to shorten their sales process, but most importantly how to scale it up. She claimed in order to do so, they in some cases must

be able to demonstrate for customers how certain catalogs of products will look on beforehand, without spending too much time on offering physical prototypes according to the industry standard. She further described how valuable it would be for upscaling if they were able to conduct this process on a larger scale with the entire assortment simultaneously. Related to this, Nordling argued that it is becoming more common for companies to offer custom creation for their customers. This in turn requires more advanced solutions for design and sales processes, where quality and e.g. material selection become crucial. However, Solback argued that as a result of these more complex processes, a greater demand for more sophisticated, yet efficient tools for communication and collaboration arose.

4.3 Applications of AR

Following the discussions on the companies' needs and issues, questions about AR were asked. First, questions regarding the interviewees familiarity with the technology were brought up, followed by questions regarding their view on potential usage within their businesses, and lastly what barriers for adoption they might, or have already, faced. Consequently, the following section has been divided into *perception*, *possibilities* and *barriers*.

4.3.1 Perception

When it comes to Augmented Reality specifically during the interviews, the level of perception of the technology differs significantly between the interviewees. Christian Rosengren, Sales Executive at Siemens Digital Industries, mentioned that AR is a small part of their business where VR is more present as of today. Nordling mentioned that they have experimented with AR glasses in the past, but have not yet figured out how to incorporate the technology into their business. This is similar to the situation at Ascom, as Norrman explained, where they have been experimenting with the AR glasses Google Glass. In healthcare it is crucial to be able to rely on technology for tasks concerning life or death and in the case of Google Glass, Norrman explained that they considered the hardware and software to be deficient in subject to their area of work. On the other hand, Norrman still believed that the technology is mature and ready for industrial use in other cases. Solback at Dassault described a situation where AR technology is "in its cradle", with lots of potential in the upcoming years within several industries.

For the more product oriented companies such as Ullman Dynamics and Awake, but also for the sales oriented GoSales, the knowledge of AR was rather low. Some of the interviewees at these companies have not heard of the technology before the interview, and some claimed that AR have not reached them with any particular value adding features (Johansson, S., personal interview, Mar 15, 2021; Welander, A., personal interview, Mar 18, 2021; Hedihn, P., personal interview, Mar 28, 2021). However, a small portion of these companies have nonetheless heard, but also been interested in implementing immersive technology into their everyday business. For instance, Telia Company with Baer as initiator, worked together with Mixtive dur-

ing the years 2017-2019 with the goal of developing a VR conference pilot. Baer explained that Telia wanted to evaluate whether the technology could be used within the organization for communication purposes. According to Baer, it was a successful project which later turned into the ongoing project with the communication platform within Mixtive, AR Call, according to Magnus Willner, CEO at Mixtive. However, this specific project was not continued due to later internal prioritization at Telia. Furthermore, Hassanci described Farm to be well aware of existing solutions with AR and its related technologies. He mentioned that they have been searching for Extended Reality solutions for communication and collaboration purposes for quite some time, but have not yet found anything suitable.

When interviewing Associate Professor at Chalmers University of Technology, Marcus Holgersson on the topic, he claimed that he is familiar with the technology but that not that much has happened during the last couple of years, despite being a fairly hyped technology. He also perceived AR to be a bit too promising in comparison to what use cases that are being showcased. Holgersson further argued that AR should not be perceived as a dead technology, but that it has had its hype and that it now shall mature in order to be commercially successful.

4.3.2 Possibilities

When asked about AR, many of the interviewees came up with several possible application areas, both for their own business but also in general. Arnesson and Norrman both mentioned the effects from the Covid-19 pandemic and how it has affected people's attitudes towards new technologies. They claimed that a wider acceptance has emerged within organisations as a result. Arnesson continued by saying that AR glasses could be useful in certain healthcare settings when handsfree solutions are considered highly valuable. Glasses in combination with AR software providing tools for communication and collaboration would be a game changer, according to Arnesson. Norrman agreed with Arnesson, and considered the technology to be mature for non-critical areas within healthcare. During almost all interviews, 2D video meetings were brought up as flat and not very engaging. Baer explained that companies, including Telia, are in the need of better communication solutions than 2D. Since he once was involved in the VR conference project with Mixtive, he sees Extended Reality as one way to go, and some value adding features could be to be able to collaborate around whiteboards or 3D models in AR or VR.

Despite Hassanci being unable to find any suitable XR solution for Farm PD, he was well aware of the tools required by them. He mentioned that the solution should facilitate collaboration between Farm PD and related manufacturers. For instance, being able to sketch and draw measurements in real time on 3D models with colleagues and business partners for evaluation purposes while remaining at different locations. In this way, Hassanci continued, Farm will be able to save both money and time by cutting out several steps in the prototyping processes, at the same time as sparing the environment due to less needed traveling with heavy, ungainly prototypes. Similar thoughts were brought up by Annvik and Johansson who both

see potential in the technology for visualization purposes. Annvik specifically mentioned the possibility of visualizing their whole assortment as a key aspect for Gafs.

Solback argued that AR will be more suited for manufacturing, where guidance of employees is important with step-by-step guides. Dassault's customers currently demand more VR solutions, but he believes that AR will be widely applied within manufacturing. He mentioned that the technology will be particularly relevant for companies that have high staff turnover, since AR can facilitate training and education of employees. Both Nordling and Rosengren mentioned the same thing, that work instructions will be highly relevant for AR technology. With the emergence of better cameras and LiDAR sensors, training and simulations will be even more applicable within the industry. They also mentioned service and maintenance remotely as an area for AR with great potential. Furthermore, Nordling claimed that companies with configurable products, hence a batch size of 1, will have great use of the technology since they can visualize the result and conduct design reviews beforehand. This goes in line with what Annvik and Johansson expressed an urge for, and as Rosengren mentioned, that digitalisation has become a more present mindset for companies of all sizes, especially after Covid-19.

4.3.3 Barriers

Despite the many possibilities for AR mentioned by the interviewees, many potential barriers were brought up as well. Arnesson considered wearables such as AR glasses to be uncomfortable and awkward to wear, since they could provide pressure on the head and face when wearing them for too long. This, according to both Arnesson and Norrman, would be major issues within healthcare since if the technology would be implemented, nurses and doctors would probably be required to use these wearables for longer periods of time. Apart from being uncomfortable, Nordling also expressed that wearables are not appealing for healthcare personnel due to its appearance. Nordling described a similar situation when operators within manufacturing did not want to wear AR glasses since they were too uncomfortable for longer periods of time. Rosengren stressed the fact that in order for AR technology to be adopted, the cost for hardware must go down but most importantly, proofs of concepts in terms of return of investment, cost savings and quality assurance must be presented.

Hassanci who has been in search for, and experimented with several, Extended Reality solutions considered many of them to be lacking in terms of performance. Some applications have lag issues and in many cases they are difficult to use for people with little to no experience. These sorts of issues are considered to be a huge barrier in terms of adoption according to Welander at GoSales, who believes that the most prominent challenge for AR technology is to provide smooth experiences for users, in their case end customers. The people who are supposed to be using the technology are the greatest barrier, according to Baer, who brought up resistance to new technologies within organizations as a major issue, which goes in line with Nordlings arguments of the culture within organizations to be a threat towards new

technologies. He argued that people have been trained to use existing technologies such as 2D video meetings for quite some time, and that you can not expect them to adopt these new technologies overnight. Willner at Mixtive lifted the same issue, explaining that during testing of their product AR Call with potential users, the usage of AR as a technology is not that intuitive to use and rather difficult to grasp initially.

According to Holgersson, people may be sceptical towards technologies that have been hyped in the past, but he still believes there is no enormous barrier for AR technology specifically. He considered the key for future success is to find good use cases within different industries and that AR will find its purpose within the foreseeable future. However, finding these use cases is not so easy, according to Christian Josefsson, CEO at the IT-consultancy company Uptive. Uptive is part of the same company group as Mixtive, and Josefsson has been involved with several of Mixtive's AR projects in the past. He claimed that, as of today, AR solutions are difficult to sell and that it is hard to mediate the actual value that can be derived from the technology. He argues that most managers at companies do not know about the technology, indicating that imagination and creativity are required from the firms providing these solutions in order to identify certain needs among their potential customers. He also mentioned that those who do know about the technology consider it to be a nice-to-have feature rather than anything that can actually provide any value. Ultimately, Josefsson declared the fact that many IT-companies articulate their engagement in the technology, despite lacking in published showcases.

4.4 AR Call

These paragraphs aim to clarify why, and how, Mixtive's product AR Call has been developed. It is done in order to understand the current product, its underlying idea and purpose, as well as its main challenges. It is described on the basis of two interviews conducted with the CEO at Mixtive, Magnus Willner, as well as lead developer for AR Call, Filip Fatic.

4.4.1 Incentives For Development

In 2016, the idea that communication being far from efficient and exciting in relation to what it could be was born. Magnus Willner then brought the idea to life at Mixtive and Inceptive Group. The initial project was partly financed by Telia Company, the project's main partner. Willner described how the project initially concerned a VR-conference app, allowing for individuals to engage in virtual conferences through VR headsets. Willner explained that today, such products see fierce competition on a market that over the past year has grown tremendously, but that it saw great novelty when introduced in 2016. While developing the VR-conference application, Willner identified further potential within the area of communication and Extended Reality technologies. He described how the lacking accessibility of headsets and an increased functionality for AR created an interest in combining the two technologies. It resulted in a new project called AR Call, an AR-application

that allows for communication using AR technology. Willner described the purpose as creating a tool for distant communication that enhances the human presence through smartphones and AR glasses with lifelike avatars, as well as being able to visualize 3D content. It was presented as the next generation of communication and got great feedback and responses from the first test users.

4.4.2 Challenges and Insights

Fatic explained how the product did not really have a specific stakeholder or end-user to work against as the project went on. Telia Company had been involved in the earlier stages of development and was occasionally engaged in tests, but not considered as the main user, nor buyer, of the branched product AR Call. The product itself was mainly tested for consumers, however businesses were considered buyers. Fatic said that they had several companies in different sectors showing interest in the product and that they tried to satisfy all needs, resulting in a project with a broad and unclear scope.

Fatic further described the project's organisation, and put emphasis on the team size. The main challenge, he said, was not having a big enough team in order to obtain better structure and clear tasks to work on. Building on this, he argues that a key learning for future development was a technological debt, which he explains as a cost of additional work that occurs as a result of previously decided solutions, and that such debt can be avoided through a more thorough and long-term planning. In the context of a small development team and tight time frames, multiple features were often being built simultaneously, creating a technological debt and issues with further development. Fatic concluded that the project has been an organized chaos that keeps evolving, seeing great potential in the technology yet without a clear scope. As more features are being added to the product, the complexity and technological debt keeps growing, perhaps hindering a future product with clear scope to even succeed technically.

Recently, the project has seen further development with a slight rephrase in product strategy and scope. Willner described how a focus on visualization of 3D-objects in combination with drawing and measuring tools has appealed to several interest groups, with for example remote product education, and that this is a feature that is being developed during the spring of 2021. However, Willner explained that one major challenge for AR in general is being able to produce 3D content efficiently, since the technology itself solely provides tools for utilizing those resources. Willner further reflected on the issues with the development process, and explained that given the changing stakeholders and the fact that the developers often are in between other consultancy projects, organizing has been a great challenge throughout the entire project.

5

Analysis

The presented empirical results are in this chapter analyzed with help of the learnings from the literature review. The chapter is split up into four sections, firstly covering AR's current state with an emphasis on the technology life cycle, followed by a thorough coverage of Christensen's characteristics for disruptive technologies. With an understanding of the technology and its potential disruptiveness, the third section covers the demand side, discussing Rogers elements of diffusion. Finally, a discussion around Mixtive's work with AR Call is further conducted, covering the previous work as well as keys for future success. Hence, the first two sections provide knowledge for answering the research question; "*How could Augmented Reality (AR) potentially be described as a disruptive innovation?*". The two succeeding sections enhance the discussion around disruptiveness and ultimately establishes a necessary wholeness in the analysis around AR as a potentially disruptive technology in order to understand the implications and possibilities for Mixtive and their future work, hence covering the second research question: "*How should Mixtive purse further work with Augmented Reality with respect to its disruptive characteristics and aspects of diffusion?*".

Clearly, AR is currently transforming several markets, products and services. Conceivably also within areas of collaboration and communication. But could it be disrupting? Answering this could guide not only Mixtive but all actors with work related to the technology, regardless of the actors' roles. However, an explicit answer to the question is argued to not be possible to make. AR has in interviews been discussed as a potential general purpose technology, and despite the difficulty in confirming the statement, it delimits the conclusion's preciseness. Consequently, AR is here rarely viewed and compared as a specific innovation but instead as a multipurpose technology, yet not definitely a general purpose technology. Accordingly, an emphasis is put on contextual applications of AR, like the focus on communication and collaboration that Mixtive has. To further define the potential disruptive characteristics for AR applied in particular contexts, a more comprehensive discussion on the current state and place in the technological life cycle is demanded, as well as observations on Christensen's disruptive characteristics applied to AR. Combining these learnings with the coverage on elements of diffusion helps the final discussion around Mixtive's product AR Call to become even more nuanced.

5.1 AR's Current State

It is clear that people for many years have had high expectations on AR, not least when looking at the well-known Gartner Hype Cycle. As Herdina (2020) illstrutates, AR could be seen as no longer an emerging technology, but instead a mature technology that is ready to be used. However, the technology was between 2009 and 2018 considered to reach the plateau of productivity in a future of 5-10 years. It implies a fixed view on the technology's potential over time, allowing for a reinforcement in expectations that constantly can not be met. Several interviewees, including Holgersson at Chalmers, Solback at Dassault and Rosengren at Siemens, express such opinions, and that it is a hindrance for further adoption. Apparently, people with a previously unbalanced ratio between expectations and experience have harder times adopting it. On the other hand, AR is mentioned by Solback and Rosengren as something that their customers will soon demand, but that they at the moment are busy demanding solutions with VR technology from their suppliers. That could be seen as an indication that AR will see similar change in expected value as the closely related VR technology has. Conclusively, the fact that AR has exited the Gartner Hype Cycle shows that an era of high, yet somewhat unspecific, expectations may be over, despite the remaining 5-10 years before entering the plateau of productivity.

Certainly, there is no shortage of agreement between more intense, realistic expectations on applied AR and a holistic view on technological paradigms. As raised by multiple interviewees, existing solutions in several areas are on one hand fulfilling their purpose but on the other hand starting to see incremental changes without any major value added to it. Baer at Telia described a great demand for solutions that allows for efficient communication and collaboration while the sustaining innovations that currently are put into existing communication solutions like Zoom are primarily nice-to-have features. Such technological development can easily be associated with the concept of technology overshooting, and to cases like Kodak's. Undoubtedly, such overshooting is a part of what Utterback (1994) refers to as the specific phase of innovation, where focus is put on incremental improvements in existing processes and products.

In contrast to the existing solutions and the argued incremental improvements, AR is now seeing what Van Der Velden et al. (2019) describe as the era of ferment. They describe an emphasized focus on research and development, and a quest for establishing standards and eventually dominant designs. These aspects are easily connected to the present work that small but even more large organisations are conducting, having for example 20 % of Facebook's workforce activated within AR and closely related areas. Utterback (1994) refers to the fluid phase of major innovation as the time where focus lies on product innovation and experimentation as a result of no certain requirements from customers, which goes in line with learnings from the interviews, that customers have often not yet realized how, and for what, AR could create business value. Companies such as Gafs Kartong, aPak, Awake and Ullman Dynamics see the potential of the technology, for example in cases of prototyping and sales, yet are still so inexperienced with the technology that the prerequisites

are scarce. The technology's traction can of course vary in other areas, however still without perfected supportive processes that often arise in the transitional or specific phase.

Building on the argument that existing solutions see signs of technology overshooting, Taylor and Taylor (2012) further describes how this part of the life cycle often opens up for new emerging technologies. It implies, understood from Figure 2.5, that it is a sequence in the very last part of a certain paradigm, one often associated with technological discontinuity. Consequently, looking at the applications of AR in certain areas like communication and collaboration while combining takeaways from interviews with theory on technological life cycles, it is arguably an opportunity for discontinuity to emerge, and for AR to eventually mature.

5.2 AR's Disruptive Characteristics

When formulating the concept of disruptive technologies and innovations, Bower and Christensen (1995) defined the characteristics that still explain whether an innovation is disruptive or not, despite Christensen et al.'s (2015) discussion around the apparent misunderstanding and misuse of the concept. The three characteristics are discussed in the following paragraphs with the first paragraph covering the different set of attributes provided, and the second paragraph covering the two remaining characteristics that concern the market with its plausible uncertainty and unattractiveness. Further on, it is clear that disruption should be seen as a process in which companies with fewer resources can successfully challenge incumbent firms, and that it can be applied to the case of Mixtive and their focus on AR technology used for communication and collaboration via the app AR Call. Additionally, with the study's abductive approach taken into consideration, the discussion on disruptive characteristics matters both AR in general as well as the specific case, however here with emphasis put on the primary one.

5.2.1 Different Set of Attributes

The first vital characteristic that should be considered is the new set of attributes that a disruptive innovation is expected to present. Looking at the definition of AR, it is said to enable interactive information that users engage with in a similar way they do with in the real world, however in a digital nature. Certainly, such a promise implies new features, aspects and dimensions of value creation. On the other hand, those are features that companies and consumers are particularly used to neither selling nor using. Christensen (1997) expressed it as innovations incompatible with current customers' demands, and such incompatibilities can fairly easily be identified with AR technology. Palm, Sales Manager at Awake, describes a constant quest for showing the high-end quality in their products and also, now in times with traveling difficulties, better ways of engaging with customers. The existing and reasonable solution is strengthened marketing efforts with high-quality renderings and great product videos. If Awake were to utilize AR as a tool for communication and collaboration with their customers, an idea could be to allow their potential

customers to engage with their products in AR. Presumably, the quality would be lower than the high-definition renderings that are displayed on their website. Most likely, some of their customers would also not be confident in choosing to use the new feature. However, those who would could be assumed to experience Awakes products in a new way and to be amazed perhaps not by the high-definition quality but over a completely new dimension of product displacement. Seeing the product in the real world, in precise scale and with the correct shapes should open up for new interactive experiences, and to new value creation possibilities. Clearly, AR is in this case delivering a completely different set of attributes towards some sales and marketing departments, similar to the one at Awake's, and could therefore be concluded as potentially having a first disruptive characteristic.

In contrast to the above conclusion, several discussions together with the interviewees were based around problems and demands that align with the capabilities of AR. Arnesson, the workflow consultant at Ascom, described a demand for hands-free solutions that would allow for better communication and collaboration around, and with, data concerning patients in healthcare. Such a solution is fairly close to parts of Mixtive's current application AR Call, allowing for interactive data displayed over the reality through AR-glasses. Similarly, the second concern raised by Arnesson at Ascom, demanding remote guidance as surgical support due to infection risks, aligns perfectly with XM Reality's platform focusing on remote guidance in particular. Furthermore, several discussions in the interviews touched upon the potential, as well as necessity, for better ways to showcase products. Welander at Gosales, Annvik at Gafs Kartong, Hedihn at Ullman Dynamics and Johansson at aPak elaborated on utilizing AR in such a way that potential customers, or other stakeholders, were able to interact with products that are displayed and experienced either in higher dimensions than the ones on the computer, or as a compliment to physical prototypes. Having the ability to fit a non-existing part as a virtual prototype to its context, for example as a part of the Ullman Dynamics seats, could help align all stakeholders both in terms of expectations but also as a part in the quality control. Allowing Annvik to employ the already existing 3D-models as virtual objects, and to present entire collections of cartongs in front of potential customers does not only reflect the entirety in a better way but also through an approach that is more effective and sustainable. Welander, who advises sales people within multiple sectors, further acknowledges a problem that suggestively is incredibly immense. Having effective customer communication partly means finding a balance between great interaction and efficient ways of communication. He stresses a need for better tools for remote selling, but still argues that sales is about human connection and that physical meetings always will play a key role. In conclusion, Welander calls for solutions that utilise technology in great ways, yet still employ human interaction. Ultimately, customers' existing demands are fairly aligned with the capabilities of, and potential with, AR technology, thus not concluded as a strong disruptive characteristic despite its new set of attributes.

5.2.2 Unattractive and Uncertain Market

Bower and Christensen (1995) referred to the second characteristic of a disruptive innovation as the consideration of financial unattractiveness for incumbents. Combining that with the third characteristic, seeing innovation on markets that are difficult to forecast and even understand, it can simply be described as innovations that exist on, or create, markets that are unattractive and uncertain. Surely, implementing AR is not a one-dimensional activity. Most applications demand key resources that previously did not exist for companies. Hardware, content and limited knowledge in the handling are some factors that could be assumed to limit usage and utility. Fundamentally, many applications would imply a certain investment for businesses, either as a result of direct costs or as opportunity cost. Indeed, being a technology that several interviewees were not familiar with, it also shows that an underlying understanding first needs to be developed. Without such an understanding, one would argue that a manager's estimation of the technology's potential revenue and business value would be even worse. This lack of understanding creates the first barrier in the quest to identify an attractiveness for incumbents, meanwhile the following big thresholds in the necessary financial investments and uncertainty regarding the technology's future further strengthens the complexity.

Taking the previously discussed high expectations into account as well as the fact that the most prominent application Pokemón Go concerns only entertainment, the innovation's attractiveness for incumbents is further questionable. What from a diffusion perspective would profit from an urge for joining into the development, a fear of missing out, is perhaps instead a predominant fear of failure. Furthermore, just as Willner, CEO at Mixtive described, early adopting individuals and eventually entire organisations might over time have burned one's bridges. Allowing for further discussion on social systems in the following sections on diffusion aspects, it should still be emphasized that the technology's novelty, it's history with great expectations and the fact that it still could be viewed as in its cradle, results in a conclusion that the market is highly difficult to both predict and understand.

Furthermore, emphasising the financial unattractiveness with what Christensen (1997) refers to as small and unpredictable potential revenues, the current market and key industry players validates this. It became prominent during the research process that few actors actually generate solid profits from AR-applications alone, especially outside of the entertainment sector. The conclusion quickly goes to show the difficulty in finding profitable business models for companies solely working with AR. Combined with the explanations around the market's uncertainty, it seems likely that the purchasing power of customers is a barrier. Josefsson, CEO at the IT-consultancy Uptive, as well as Willner, CEO at Mixtive, both stressed the issues in selling new technologies. Taking into consideration that Josefsson requested great intuity for consumers, it highlights a dilemma for AR. In many cases, it is not intuitive. Also, not only as a buyer but also as the seller and developing firm of the innovation, AR further shows difficulties with different requirements in knowledge and resources from what IT-companies perhaps usually employ, for example in the case of necessary 3D-content. Again, showing the financial unattractiveness for in-

cumbents.

Clearly, AR as a technology in general shows a strong disruptive characteristic in the aspect of uncertainty and difficulty to forecast and understand. In more narrow contexts and applications, such predictions get even more difficult. Forecasting emerging technologies and markets is of course a challenge, however seeing a technology with such a movement on the Gartner Hype Cycle is remarkable. Also, the amount of forecasts is arguably low, and seeking knowledge from those perhaps do not guide more than just a clarification of having great potential. On the other hand, Deloitte (2018) wrote that adoption would increase massively when seeing technological improvement. It was written the same year, 2018, as AR disappeared from the Gartner Hype Cycle. Arguably, 2018 is a landmark, and the expectations are since then perhaps more realistic and concerning a more nearby future, and could despite the recent years' great development suggest Deloitte's projection to be somewhat inaccurate.

Christensen et al. (2015) further emphasize the different types of markets in the discussion around disruptive innovations, where they originate and exist. He explicitly states that disruptive innovations materialize in either low or new-end market footsholds. In broad terms, AR can most likely not be declared as a technology that originates in low-end footholds. Such a foothold would imply that there exists customers that incumbent firms overlook, perhaps due to being a less profitable segment, and that AR in that case could capture these customers with a modest product that initially is good enough. As previously clarified, AR demands both great resources and investments in order to realize the potential, inherent value. This holds true for the area of communication, where many services that incumbents offer today are both easy to use and cost-effective, if looking at examples like the videoconferencing programs mentioned in the interviews. The same holds true for more standardized ways of visualizing products. Solutions clearly exist that are simple and cheap enough to avoid overshooting certain customers' demand and financial resources. On the other hand, there surely exists some applied AR-opportunities that could emerge in low-end market footholds, as in the case for web-based AR. It gives customers an opportunity to access functionality that normally is way more complex and inaccessible, as well as much more costly. Web-based AR could be a way for smaller companies to display products in not only a more engaging way, utilized in both sales and marketing meanwhile saving money on for example physical prototyping. These potential customers could currently be classified as unserved, either as a result of being a low-end foothold and therefore overlooked, or as a new-market foothold for the technology, depending on perspective. Emphasizing the cost-aspect besides the utilization of web-based AR, one would rarely view AR as taking low-end footholds, but instead as a technology that possibly can turn nonconsumers into consumers through new-market footholds.

Expanding on different market footholds, Arnesson at Ascom expressed needs that apply to the discussion. Doctors are in constant need of visualizing necessary information about patients, which could be a stream from another operating room,

pre-loaded X-rays or vital real-time data on certain patients. Such information is obviously available today for healthcare personnel with existing solutions but not in a way that is desired. Arnesson referred to hands-free communication and collaboration within healthcare as something that would create great value. Elaborating the idea of hands-free collaboration, doctors would then be able to visualize the necessary information through a pair of AR-glasses. By utilizing AR with hands-free functionality from AR glasses, it could potentially turn non-consumers into consumers, thus emerging in a new-market foothold.

Similarly, Hassamanci at Farm PD expressed a distinct need for visualising their large and often complex products in more holistic ways, including the ability to allow their customers to experience the products as a part of their real environment. As of today, solutions involve computer renderings and physical visits to see real products. All in all, it reduces Farm PD's ability to showcase and sell products efficiently. Surely, Farm PD is far from the only company being limited to combining renderings, physical meetings and showrooms, while having products that require an experience united with its surroundings. In conclusion, Hassamanci described a distinct demand that Farm PD experiences which also applies to more general contexts. It presents demands that currently do not have one integrated, whole solution, but which through an AR application could be solved for. Such an application would turn non-consumers into consumers, and enable Farm PD to visualize their products in the correct place, nevertheless remotely.

Building on the discussion around low-end or new-market footholds, Christensen et al. (2015) further highlight the debate on sustaining innovations. It is as argued often rational to seek sustaining innovation, as well as easier to motivate. Just like Norrman described how Ascom continuously seeks to solve the described issues for customers within healthcare, it clearly matters about existing products and development of those, perfectly aligned with the definition of sustaining innovation. Looking at AR as a new technology introduced in several areas of applications, communication and collaboration being one of them, it could be expected to influence and stimulate how existing technology develops. Taking into consideration that the current place on the technology life cycle is rather early and still not at the steepest point of the S-curve, both for Foster (1986) and Adner's (2004) interpretations, one could claim that the diffusion process and the technology's competitive threat will trigger the development of existing solutions even further. Ward (1967) defined this phenomena as the sailing ship effect and looking at AR and its different applications there exists several potential scenarios. Fundamentally, AR could have the ability to change behavior due to its core capabilities, "provide stimuli to cause the participants to believe that something is occurring that really is not", and consequently change how people perceive, use and demand technology. An imagined result could be the example that Welander is expecting for the future, that people assume to have the opportunity to virtually try out a product before purchasing it, even customized one's. If companies without such an AR opportunity, or competitors to the company offering the AR application, were to compete against such a solution, they would clearly need to revise not only their products but perhaps also their business

model. Fundamentally, the consequences of well implemented and utilized AR technology is surely a stimulus for further development in many areas, perhaps for other innovations in line with the sailing ship effect, but also in general as a societal force.

In conclusion, AR surely has the potential not only to transform but also to disrupt. Christensen's three characteristics of disruptive innovation concern firstly a different set of attributes that is incompatible with current demands, secondly a financial unattractiveness and thirdly an uncertain market that is difficult to understand and predict. AR offers a value proposition that on one hand often aligns with current demands, yet generally features attributes that certainly are different from existing solutions. AR is likely to be considered financially unattractive due to the involved risks in a market with high expectations and fewer proofs of profitability. Also, the irregularities in both expectations and predictions combined with high complexity implies a high degree of uncertainty. Hence, AR to some extent encompasses Christensen's characteristics. However, looking into the two different footholds where disruptive innovations are expected to originate from, the increased complexity becomes evident. For it to originate from low-end footholds, it needs to serve as an application that is easier to utilize in terms of both usage and investments. Regarding new-market footholds, AR surely has great potential, notwithstanding a challenging need for easy access to new value propositions that are simply just good enough in some aspects. Finally, AR's fundamental revolutionary capabilities of creating solutions in, and with, new dimensions, will inevitably stimulate society and other innovations, including sustainable ones.

5.3 Diffusion of AR

In order to draw any further conclusions for AR and its future adoption and diffusion, the following sections cover Rogers' (2003) four elements in the diffusion of innovations. Firstly, a thorough section about the innovation itself is presented, where discussions are based on Rogers' (1983) five characteristics of an innovation; *relative advantage*, *compatibility*, *trialability*, *observability* and *complexity*. Secondly, communication channels and their difference in efficiency are discussed, followed by a section about the role of social systems and how they constitute boundaries for diffusion. Rogers (1983) considers the fourth element, time, to be an aspect of all activities in a diffusion process and that it does not exist independently from events. Hence, any further discussions about time as an element is not brought up.

5.3.1 The Innovation

It is clear that AR is becoming more available for both individuals and organizations, hence fulfilling Rogers' (1983) characteristic of an innovation's trialability. The most drastic changes can be seen in the consumer market where smartphones today possess the required software to launch AR applications. Additionally, with developments within so-called web-based AR, users are no longer required to download certain applications in order to use the technology, but can now try out the technology on different websites. Rogers (1962) explained that potential adopters

are motivated to seek further information about the innovation in question in order to cope with uncertainty, since they are interested in knowing more about the probability of the innovation being a superior alternative to existing solutions. Therefore, one can argue that AR has been given great conditions for adoption and diffusion when the technology is available for everyone to try, hence uncertainty about the technology might be decreased at a more rapid pace.

While the future potential might seem bright for AR within the area of communication and collaboration, the perceived value gained from the technology as of today differs. Companies such as Siemens and Ascom have already been experimenting with the technology but have been unable to find any particular use of the technology in their business so far. However, there are examples of companies within certain industries that have adopted AR, but as Holgersson at Chalmers mentioned, sometimes it seems a bit too promising in many of the use cases that are being showcased on the market. This might indicate that the adoption of the technology will move slower than what some might hope for, given that the relative advantage of AR is not perceived as high as it often is presented. Arguably when a new technology is introduced, some sort of learning curve should become apparent for users who adopt. For applications involving AR technology that are not so complex, the learning curve might seem very steep, as in the case with Pokemon Go where hundreds of millions of people started playing during the first couple of years. However, when combined with more advanced features as in the case with communication and collaboration, the learning curve could be seen as much flatter. Despite actively searching for a solution incorporating the technology, Farm PD has still not been able to find a solution that is on one part suitable for their needs, but perhaps almost as important, easy to use. As Baer and Nordling mentioned, individuals might be considered to be the highest barrier to adoption, since one cannot expect people to instantly learn how to use a new technology. This can be argued to become a severe issue for AR's future adoption, if the technology in its nature is considered difficult to use. When interviewing Willner at Mixtive, these exact issues were lifted when he was asked about the historical testing of AR Call among consumers. Even though the technology in some cases might not be that complex to use, the technology does not seem intuitive to the common man, hence further increasing the barriers for adoption.

As Rogers (2003) mentions, innovations that are compatible with prevalent norms and values of a social system will be adopted more quickly. Given the novelty of AR technology, ethical concerns might be considered a potential barrier for future adoption. Since AR devices are equipped with sensors that capture information about the user's surroundings, ethical concerns regarding privacy may be problematic. One could argue that people today are used to the usage of smartphones where photographs and videos are being captured everywhere, indicating that the introduction of AR glasses would not be as problematic as some skepticists might think. However, it should be considered an important aspect for developers when introducing new AR applications and devices to the market.

Given the fact that the applications of AR within communication and collaboration aim at bringing efficiency and quality into the processes, the results of doing so may be considered to be observable. Rosengren mentioned that proofs of concepts must be presented in order for AR's future diffusion and adoption to accelerate. By implementing AR as a new tool in an organization for e.g. collaboration in design processes, results of doing so might send significant signals to competitors and other industries. However, one of the main problems for AR today seems to be the struggling of finding good use cases, explained by Holgersson. It undoubtedly reminds of a catch-22 situation, where AR needs good use cases in order to accelerate adoption, but in order to get there, results must be presented. One could argue that AR has reached its early adopters, where some actors within the industry have benefited from the technology. From a diffusion perspective, reaching the so-called early majority could be problematic given the technological uncertainties and perceptions of AR being a nice-to-have technology rather than value providing.

5.3.2 Communication Channels

As Rogers (1983) mentions, communication channels must be present in order for innovations to diffuse. He also brings up the effectiveness of communication within settings of homophilous nature. Given that the technology is new, that not many know about its existence and that the availability previously has been limited, one can assume that most communication taking place about AR is within homophilous groups. This, according to Rogers (1983), indicates that further diffusion is hindered considering the necessity of having heterophilous communication channels as well. In order for this to occur, the technology must become even more available to enable communication and interaction in heterophilous groups. However, one can conclude that the technology is not that facile to grasp and even more difficult to explain to another individual. Just as Josefsson mentioned during the interview, selling AR related projects is difficult due to the fact that the value proposition might be hard to explain in words. It seems clear that in order to demonstrate the real value that AR can provide, one must present the solution in question in its intentional context. Given that the technology is new, a majority cannot relate to what is being described. Proper demonstrations combined with clear guidance of how to use the technology would seem the most appropriate approach to give way for further diffusion. On the contrary, despite being difficult to grasp, the novelty of the technology itself might contribute with a certain curiosity among individuals which in turn might lead to an increase in adoption. Early adopters, according to Rogers (1983), may accept faults and incomplete features from an innovation to a greater extent, indicating that the aspect of curiosity might be sufficient for eventual adoption. Therefore, it should be considered crucial for businesses developing AR applications to utilize a beachhead strategy as described by Moore (1991) to target critical groups of potential early adopters.

5.3.3 Social Systems

Rogers (1983) emphasizes that diffusion takes place within a social system, and that the system constitutes a boundary for how an innovation is being diffused. It has become clear that AR has the potential to provide substantial value for several industries. Despite the potential, barriers in terms of rigidity put a hold for possible diffusion within some of these industries. One example is the healthcare industry, where bureaucracy and rigid processes are hindering potential usage of AR, despite being expressed as a technology that could do great good for several areas within healthcare. Nonetheless, Norrman at Ascom mentioned that they have experimented with the technology and deemed it as inadequate, but one can argue that experimentation solely with Google Glass does not do AR glasses justice considering the many options that are available today. Furthermore, Arnesson at Ascom expressed a need for wireless communication devices with integrated guidance systems and collaboration tools. Again, these sorts of needs go perfectly in line with what AR can do, and it has become apparent that in many cases the problem does not lie within the solution itself, but rather in the social system where rigidity within an organization puts a hold on further diffusion and implementation.

In addition to barriers in terms of rigidity, the social systems concerning AR need an emphasis put on the individuals. Grewal et al. (2000) discuss private versus public consumption of innovations and the effects on adoption rates of new innovations, primarily in the early parts of the diffusion process but also in later stages. AR may be considered as a privately consumed innovation for most applications. For businesses, AR could function as a tool for employees to utilize within for example product development processes. For consumers, an adopted and consumed AR application would rarely create direct impressions beyond the individual itself. In both cases, the privately consumed innovation does not create any additional incentives for adoption and diffusion as results of social-identity functions. However, in cases like the previously discussed product visualization opportunities that AR brings, companies would surely be able to utilize social functions. Such circumstances would strengthen the likeliness of AR's continued diffusion. Surely, an innovative company, in any area, could see an interest in engaging with a technology like AR as a way to strengthen the brand image by showing they work with the latest technologies. A complication with cases like those is the fact that the technology itself is both rather complex in its development and value creation, and that companies therefore could either fail, or back off due to a fear of failure. Hence, in theoretical terms, it could imply that companies communicate to others that they work with AR, despite not doing it successfully, as a way to simply strengthen their attractiveness. This is argued to be true based on the market research and Josefssons statement, that many companies seem to work in the area at first glance, yet have few actual use cases. One could argue that the fear of missing out on AR will have a positive impact on the technology's further diffusion, however when again emphasizing what Josefsson referred to as a need to find clear value propositions, AR's reaction is dubious. In conclusion, social-identity functions will clearly have an impact on the adoption and diffusion, and since the technology is getting more available for the general public to use, one can expect the positive impact of publicly

consumed goods to soon accelerate the technology's growth even further.

Furthermore, since the expectations one AR generally are high, combined with the difficulties in usage and lack of performance, a wider availability might lead to the opposite effect. This tradeoff between performance and diffusion is crucial for the future adoption of AR. Arguably, diffusion is considered key due to amongst others, the absence of dominant designs. In this case, the question of dominant design is argued to be around how AR applications are being developed, not the technology itself. The development of the technology is dependent on feedback from users, which must come from all groups of society since AR is applicable for so many different areas. Despite initially lacking in performance in certain areas, the technology will not cease to exist. Instead, one could expect iterative performance improvements that will ensure that users' expectations eventually are met, as well as dominant designs for its development processes.

5.4 Essentials for Mixtive

In order to guide Mixtive in their future work with AR and especially within communication and collaboration with AR Call, key learnings from the interviews are combined with the preceding analysis on the disruptive characteristics, diffusion and current state of AR. It is executed by first emphasizing the key learnings from Mixtive's previous work with a following emphasis on AR Call's challenges and possibilities. With such understanding follows a comprehensive discussion around the market in which Mixtive competes against both competitors but also the market itself. Summarizing the learnings from the chapter, a final guidance to Mixtive concludes the section.

5.4.1 AR Call

AR Call has been an ongoing project for several years in an industry where rapid development is taking place, and it certainly has great potential of fulfilling needs that align with companies' prioritized challenges according to the empirical findings above. The project itself however infers severe challenges in terms of project scope and involving suitable stakeholders. As both Magnus Willner and Filip Fatic at Mixtive explained, the product has been tested for consumers, whereas its main intent is to be sold to businesses. Also, Fatic explained that many features are being added to the application without any further consideration about what the added value might be. Hence, the scope of the project might seem a bit unclear and in order to be commercially viable, Mixtive should consider prioritizing what features that should be included and emphasized when targeting potential customers.

Regarding communication, it has become evident from the sections above that existing solutions such as 2D-video do not have any vital problems. They work rather well, with small additional features being added continuously. AR would therefore not solve a completely new problem that is demanded from the users, but rather enhance existing solutions through a better feel of presence and engagement. Since

it is considered an add-on for communication solutions, and that the main need is in a sense already met, adoption of AR for communication purposes will most likely experience lags in adoption. Consider for instance screen sharing in 2D-video meetings. The same procedure can be accomplished in AR, i.e. that the shared screen shows in the user's field of view in their smartphone or AR glasses. Hence, that specific feature can be argued not to provide any additional value to the concept of communication. On the other hand, if applying hands-free functionality as Arnesson inquired, certain industries might benefit from implementation of AR. If applied to the case of healthcare, it can be argued that Mixtive's product AR Call could be a suitable solution, given that it already has support for communication with AR glasses. Features such as lifelike avatars would probably not provide any certain value in that specific case, considering information is the central area of interest. However, avatars could be relevant where for instance straightforward conference calls between employees is the case. Consequently, AR Call is certainly suitable for several use cases within the area of communication, but considerations regarding what features that should be included should be lifted.

In addition to communication, several interviewees including Baer at Telia and Löfgren at Around the Corner, concluded that organizations are in great need of better solutions for remote collaboration, especially in times of social distancing and remote work. Farm PD statutes the perfect example of an organization with those specific needs, where existing solutions simply are not enough. Hassanic explained that being able to share objects in 3D is considered a crucial feature for design and review purposes, and similar thoughts were expressed by other interviewees within the areas of sales and prototyping. As Willner at Mixtive explained, new features for AR Call are currently being developed. He explained that AR Call has previously been able to visualize 3D content, but not in a way that enables for interaction with other users. Given that AR Call already has vital features such as communication functionality with AR glasses and lifelike avatars, if being successful with implementing 3D content interaction through e.g. drawing and measuring, use cases similar to those of Farm PD involving design and prototyping would be highly suitable.

5.4.2 Succeeding with AR Technology

In addition to the particular conclusions regarding AR Call, several discussed matters apply more broadly to AR technology and Mixtive's work in general. First and foremost, one should consider AR as a potentially disruptive technology with features that expands beyond existing solutions. Indeed, a great challenge, and so is aligning those features with demands agreeing with companies' prioritizations. Despite the fact that several markets that are touched upon in this study conforms to Christensen's idea of overshooting technologies, AR does arguably not have an obvious path forward. Seeing technologies overshoot could for innovators with an understanding of disruptive innovations' development imaginably create a sense of assuredness, yet with an emphasis on what Christensen et al. (2015) highlight, one should assert more than just an unserved low-end market. This holds in particular for AR and for Mixtive. In order to diffuse, and in some cases potentially disrupt,

traction is likely to originate from new-market footholds. Perhaps more likely than from low-end market footholds, despite the obviously sustaining innovative efforts amongst existing solutions and thus a market that conceivably is ready to see either disruptiveness or technological discontinuities. The argument develops from the discussion around disruptive innovations' characteristics applied to AR, and the hyped technology's continuous difficulties in appearing as a technology that is easy to understand, access and use, while also being value-fulfilling. Reflecting upon this struggle in the discussion of AR as an innovation itself, and the probability of being described as a general purpose technology, it may be concluded that AR will see a majority of new-market foothold advancements. Consequently, Mixtive should first and foremost not strive for competing against existing solutions in ways that regular sustaining innovation does, nor emphasize the existing demands of the potential customers, but instead focus on targeting the customers' experienced problems. Undoubtedly, it implies that a reasonable approach to AR as a technology is to describe it as a potentially disruptive one, and to organize businesses and manage products accordingly.

Experimenting with emerging technologies is essentially a tough challenge to face if one seeks to establish profitable business early on. Above all, working with AR is not only demanding in terms of software development, but even more challenging on the market side. Mixtive has experienced the difficulties in offering customers solutions to existing problems that are both new and unexpected, with a technology and market that is not easily understood and with existing competition from previous solutions that often do meet customers' expectations and demands. Viewing AR within communication and collaboration as a potentially disruptive technology, AR Call features the same attributes and should therefore be managed accordingly. Thus, a key insight for Mixtive is to treat it as an innovation that will likely originate from a low-end or new-market foothold, and gradually overtake existing solutions' market shares. Mixtive should therefore not seek to explicitly try to replace existing solutions, but instead start narrow and confirm how these new sets of features are adopted and utilized. This market confirmation, despite being a small targeted group, allows for both better diffusion across the different groups as well as for an iterative and more closely connected development of the product itself.

Furthermore, when considering AR Call to have the best appliance within collaboration, it obviously results in a recommendation to define a narrow scope that puts collaboration in the center of attention. A narrow scope will also help Mixtive in continuing with efficient and well-managed product development. Based on the discussions around disruptive characteristics, the product scope should further be defined with the reminder that the product could comprise the new dimensions of features yet still be somewhat underdeveloped in other areas. However, recalling the discussions around the technology's necessary simplicity and overlying uncertainty, one needs to consider balancing underperformance and ease of use. It should also be noted that in order to emerge in low-end footholds, the pricing needs to be adjusted accordingly. It implies that Mixtive and other firms on the market should embrace necessary pricing strategies that initially could seem less profitable. It should also

be declared that the primary market for Mixtive is B2B, based on the learnings from the market and technology's adoption and diffusion. Eventually, adoption will proceed and get stronger in business direct to consumers, and at that moment see further growth as a bigger part of the social system. The social forces will most likely have a big influence on the diffusion over time, due to the many uncertainties for businesses and the fact that it now at first is mainly a privately consumed innovation. Initially, with an emphasis put on the acknowledgement of the place in the life cycles and diffusion process, Mixtive should seek to first properly align with their different groups of potential early adopters, before then utilizing the beachhead strategy as their way to cross the chasm. Also, one must take into consideration that AR Call and its utilized AR-technology still takes place early on in the fluid phase of Utterback's (1994) technology life cycle, exists late in Taylor and Taylor's (2012) defined paradigm and appears early in the first phases of Rogers' (2003) adoption curve. Recognizing these facts help Mixtive understand the need for adaptability. One could assume it to arise great discontinuities in the nearby years, and in some way view the competitiveness amongst the big actors like Apple, Google and Facebook as the "AR race" setting up for a soon achieved dominant design when it comes to the development of AR applications. Utterback argues that companies that engage in the development prior to a reached dominant design will benefit from it, and Mixtive will arguably also benefit from the improved technological base and increased demand.

6
Conclusion

This study has investigated if, and how, Augmented Reality (AR) can be described as a disruptive innovation. Taking into consideration its many areas of applications and being a potential general purpose technology, the disruptiveness' guidance is rather weak and therefore combined with a thorough review around the technology's aspects of diffusion and the technology life cycle. Consequently, strategic advice for Mixtive and their work with AR in general and AR Call in particular has been provided on the basis of the study's results. The research is argued to contribute not only to Mixtive, but also to companies working within the industry of AR in general, as well as companies facing strategic decisions involving potentially disruptive innovations.

The expectations on AR have been high for a long time. It has gone from being considered an emerging technology to a technology that in a not so distant future will mature. Within communication and collaboration, existing solutions are considered to be in a phase at the end of a paradigm where small, incremental improvements are occurring, essentially indicating signs of technologies that are overshooting existing demands and opportunities for discontinuities. However, with the observation that pure communication is not enhanced as much as collaboration is with objects shared in AR, the latter area of utility becomes the most attractive one. Furthermore, in the context of the technology's disruptive characteristics, AR provides in many cases different sets of attributes compared to existing solutions. Also, the market of AR is not very financially attractive for incumbents, despite its long hype. This is due to rather high barriers and vast uncertainties regarding the technology's future, indicating on one part that AR seems to align with the definition of disruptive innovations. On the other hand, despite being a technology that few are familiar with, it often aligns with current needs of customers, hence indicating the opposite of what is expected from disruptive innovations. Independently of the interpretation, AR undoubtedly brings transformational capabilities to markets as well as companies, yet with an unpredictable nature. It ultimately results in a technology that still is in its early stages of the technology life cycle, but at this moment ready to accelerate and create a new technology paradigm, firstly in the area of collaboration but eventually in a broad range of applications.

In summary, from the analysis of AR as a potentially disruptive technology with the applied life cycle analysis and aspects of diffusion, the following strategic recommendations are advised to Mixtive in general and their work with AR Call in particular:

- Do not seek to replace existing solutions in their entirety, but start small and expand functionality over time, both in low-end and new-market footholds
- Define a clear scope with intent of solving a distinct problem, suggestively within product-oriented collaboration
- Be flexible in order to cope with coming changes on both the demand- and supply side for AR technology, as well as noticing changes in acceptance and complementary technologies
- Engage in declaring AR's true value and potential and educate customers as well as non-customers on the technology

For future research on the topic of AR technology in the context of disruptive innovation and discussions around its diffusion, a suggestion follows. When concluding that AR for pure communication should not be the top priority for Mixtive, it opens up for an insightful investigation of the current state of communication. Undoubtedly, Covid-19 has had a strong impact on the current state of communication, and with respect to the concluded location at the end of a technology paradigm, it ultimately speaks for great development, with or with the early involvement of AR.

Bibliography

[1] Adner, R. (2004). A demand-based perspective on technology life cycles. In: Baum, J.C., McGahan, A. (Eds.). Advances in strategic management volume 21: Business strategy over the industry life cycle. *Emerald Group Publishing Ltd.* 25–43.

[2] Adner, R. & Levinthal, D. (2001). Demand heterogeneity and technology evolution: Implications for product and process innovation. *Management Science.* 47(5). 611–628.

[3] Anderson, P., & Tushman, M. L. (1990). Technological discontinuities and dominant designs: A cyclical model of technological Change. *Administrative Science Quarterly.* 604–633.

[4] Apple. (2021). *AR Quick Look.* Retrieved 2021-02-25 from https://developer.apple.com/augmented-reality/quick-look/

[5] Apple Insider. (2021). *"Apple Glass" rumoured features.* Retrieved 2021-03-12 from https://appleinsider.com/inside/apple-glass

[6] Azuma, R., & Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications. 21*(6). 34–47.

[7] Beauchamp, D. (2018). *Shopify AR makes shopping in Augmented Reality a reality for small businesses.* Shopify. Retrieved 2021-04-03 from https://www.shopify.com/blog/shopify-ar

[8] Bernard, H. R. (2006). *Research methods in anthropology. Qualitative and quantitative approaches.* Rowman Altamira, Lanham.

[9] Bilton, N. (2015). Why Google Glass broke. *The New York Times.* Retrieved 2021-03-18 from https://www.nytimes.com/2015/02/05/style/why-google-glass-broke.html?referer=https%253A%252F%252Fwww.google.com%252F

[10] Blum, A. (2018). Ethical challenges of Virtual and Augmented Reality. *Insights Success.* Retrieved 2021-05-17 from https://www.insightssuccess.com/ethical-challenges-of-virtual-and-augmented-reality/

[11] Boland, M. (2020). 2021 Predictions: Mobile AR exceeds 800 million users. *AR Insider.* https://arinsider.co/2020/12/16/2021-predictions-mobile-ar-exceeds-800-million-users

[12] Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: Catching the wave. *Harvard Business Review.* https://hbr.org/1995/01/disruptive-technologies-catching-the-wave

[13] Bresnahan, T. F., & Trajtenberg, M. (1995). General purpose technologies 'Engines of growth'?. *Journal of Econometrics*, *65*(1), 83–108.

[14] Bryman, A. (2002). *Samhällsvetenskapliga metoder* (1st ed.). Malmö: Liber ekonomi.

[15] Bryman & Bell (2015). *Business research methods* (4th ed.). Cambridge ; New York, NY: Oxford University Press.

[16] Byford, S. (2021). Almost a fifth of Facebook employees are now working on VR and AR: report. *The Verge*. https://www.theverge.com/2021/3/12/22326875/facebook-reality-labs-ar-vr-headcount-report

[17] Castellanos, S. (2021). Augmented Reality gets pandemic boost. *The Wall Street Journal*. https://www.wsj.com/articles/augmented-reality-gets-pandemic-boost-11611866795

[18] Chang, S. & Fan, C. (2016). Identification of the technology life cycle of telematics: A patent-based analytical perspective. *Technological Forecasting & Social Change*, *105*(2016), 1–10. http://dx.doi.org/10.1016/j.techfore.2016.01.023

[19] Chau, P., & Hui, K. (1998). Identifying early adopters of new IT products: A case of Windows 95. *Information & Management*, *33*. 225-230. 10.1016/S0378-7206(98)00031-7

[20] Cheng, J. C. P., & Chen, W. (2017). Comparison of marker-based AR and markerless AR: A case study on indoor decoration system. *Proc. Lean & Computing in Construction Congress*, *2*. DOI: 10.24928/JC3-2017/0231

[21] Christensen, C. M. (1997). The innovator's dilemma: When new technologies cause great firms to fail. *Boston, Massachusetts, USA: Harvard Business School Press*. ISBN 978-0-87584-585-2

[22] Christensen, C. M., Raynor, M. E., & McDonald, R. (2015). What is Disruptive Innovation. *Harvard Business Review* (December 2015). ISSN 0017-8012

[23] Craig, A. B. (2013). *Understanding Augmented Reality* (1st ed.). Morgan Kaufmann, Elsevier. ISBN: 978-0-240-82408-6

[24] Dalen, M. (2015). *Intervju som metod* (2nd ed.). Gleerups Utbildning AB. ISBN: 9789140688293

[25] Deloitte. (2018). *Augmented Reality*. Retrieved 2021-04-13 from https://www2.deloitte.com/uk/en/pages/consumer-business/articles/what-is-augmented-reality.html

[26] Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2015). *Management and business research* (5th ed.). Sage Publications Ltd.

[27] Eisenhardt, K. (1989). Building theories from case study research. *The Academy of Management Review*, *14*(4), 532–550. doi:10.2307/258557

[28] Ejvegård, R. (2003). *Vetenskaplig metod* (3rd ed.). Lund: Studentlitteratur.

[29] EON Reality (2021). *EON Reality: Augmented and Virtual Reality solutions*. Retrieved 2021-02-05 from https://eonreality.com/

[30] Eriksson, L. T. & Wiedersheim-Paul, F. (2014). *Att utreda, forska och rapportera* (10th ed.). Stockholm: Liber.

[31] Fitzpatrick, R. (2014). *The mom test: How to talk to customers and learn if your business is a good idea when everyone is lying to you*. CreateSpace Independent Publishing Platform. ISBN 9781492180746

[32] Ford, D., & Ryan, C. (1981). Taking technology to market. *Harvard business review*, 59(2), 117–126.

[33] Foster, R. N. (1986). *Innovation: The attacker's advantage* (1st ed.). Guild Publishing, London.

[34] Games Press. (2021). *Red Bull launches augmented reality games featuring five Red Bull athletes with "Discover your wiiings".* https://www.gamespress.com/red-bull-launches-augmented-reality-games-featuring-five-red-bull-athl

[35] Gargoum, S. A., & Karsten, L. (2021). Virtual assessment of sight distance limitations using LiDAR technology: Automated obstruction detection and classification. *Automation in Construction*, 125(2021). https://doi.org/10.1016/j.autcon.2021.103579

[36] Gartner. (2021a). *Definition of SDK (software development kit).* Retrieved 2021-05-14 from https://www.gartner.com/en/information-technology/glossary/sdk-software-development-kit

[37] Gartner. (2021b). *Gartner Hype Cycle.* Retrieved 2021-05-08 from https://www.gartner.com/en/research/methodologies/gartner-hype-cycle

[38] Guba, E. G., & Lincoln, Y. S. (1994). *Competing paradigms in qualitative research.* In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 105-117). Thousand Oaks, CA: Sage.

[39] Grant, R. M. (2019). *Contemporary strategy analysis* (10th ed.) Wiley. ISBN: 9781119495673

[40] Greenwold, S. (2003). *Spatial computing.* [Master thesis, Massachusetts Institute of Technology]. https://acg.media.mit.edu/people/simong/thesis/SpatialComputing.pdf

[41] Grewal, R., Mehta, R., & Kardes, F. (2000). The role of the social-identity function of attitudes in consumer innovativeness and opinion leadership. *Journal of Economic Psychology*, *21*(3), 233–252.

[42] Gstoll, A. (2016). A love letter from augmented reality to Pokémon Go. *Mixed-Reality I/O.* https://www.mixed-reality.io/10-ways-to-engage-with-your-clients

[43] Herdina, M. (2020). Augmented Reality disappeared from gartner's hype cycle – What's next?. *AR Post.* https://arpost.co/2020/09/25/augmented-reality-gartners-hype-cycle/

[44] Hobbs, R. (2020). Gucci Partners with Snapchat for AR Try-On. *Stylus.* https://www.stylus.com/gucci-partners-with-snapchat-for-ar-tryon

[45] IKEA. (2017). *Nya IKEA appen är här - ladda ner världens minsta IKEA varuhus till mobilen.* Retrieved 2021-02-05 from: https://www.ikea.com/se/sv/customer-service/mobile-apps/

[46] Johansson, N. (2018). Varför Mixed Reality är en problematisk term för VR/AR. *Immersivt.* https://www.immersivt.se/mixed-reality-problematisk-term-vr-ar/

[47] Johannesson, P., & Perjons, E. (2014). Research strategies and methods. In: An introduction to design science. *Springer, Cham.* https://doi.org/10.1007/978-3-319-10632-8_3

[48] Jun Aw, B. (Dec 8, 2020). Why Instagram AR filter is the future for Instagram marketing. *Medium.* https://medium.com/supercampus-asia/why-instagram-ar-filter-is-the-future-for-instagram-marketing-8ae87b089dda

[49] Kaplan, S. & Tripsas, M. (2008). Thinking about technology: Applying a cognitive lens to technical change. *Research Policy*. 37(5). 790–805.

[50] Kipper, G., & Rampolla, J. (2012). *Augmented Reality : An emerging technologies guide to AR* (1st ed.). Elsevier Science & Technology Books. ISBN 9781597497343.

[51] Langmeyer, N. (2015). The disruptive potential of Augmented Reality. *World Economic Forum*. https://www.weforum.org/agenda/2015/01/the-disruptive-potential-of-augmented-reality/

[52] Langston, J. (2021). "You can actually feel like you're in the same place": Microsoft Mesh powers shared experiences in mixed reality. *Microsoft*. https://news.microsoft.com/innovation-stories/microsoft-mesh/

[53] LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research*, *52*(1), 31–60. https://doi.org/10.3102/00346543052001031

[54] Lopez, G. (2016). Pokemon Go, explained. *Vox*. https://www.vox.com/2016/7/11/12129162/pokemon-go-android-ios-game

[55] Mack, N., Woodsong, C., Macqueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative research methods: A data collector's field guide* (1st ed.). Family Health International. ISBN: 0-939704-98-6

[56] Makarov, A. (2021). 10 Augmented Reality trends in 2021: The future is here. *Mobidev*. https://mobidev.biz/blog/augmented-reality-future-trends-2018-2020

[57] McDowell, M. (2020). How 5G will change AR and digital fashion. *Vogue Business*. https://www.voguebusiness.com/technology/how-5g-will-change-ar-and-digital-fashion

[58] Milgram, P., Utsumi, A., Takemura, H., & Kishino, F. (1994). Augmented reality: A class of displays on the reality-virtuality continuum. *Telemanipulator and Telepresence Technologies*. 2351. 10.1117/12.197321.

[59] Moore, G. A. (1991). *Crossing the chasm: Marketing and selling high-tech goods to mainstream customers* (1st ed.). New York: Harper Business. ISBN 0-06-018987-8

[60] Naisby, N. (2018). AR as a disruptive innovation... or just another trend?. *Fox School of Business*. https://digitalmarketing.temple.edu/nnaisby/2018/10/17/ar-as-a-disruptive-innovation-or-just-another-trend/

[61] NEC. (2020). *How Virtual Reality and Augmented Reality are disrupting the enterprise*. Retrieved 2020-03-10 from: https://www.nec.com/en/global/insights/article/2020022509/index.html

[62] Orcik, A., Tekic, Z., & Anisic, Z. (2012). Customer co-creation throughout the product life cycle. *International Journal of Industrial Engineering and Management (IJIEM)*, *4*(1), 43–49.

[63] Park, M. K., Lim, K. J., Seo, M. K., Jung, S. J., & Lee, K. H. (2014). Spatial augmented reality for product appearance design evaluation. *Journal of Computational Design and Engineering*, *2*(2015), 38–46. http://dx.doi.org/10.1016/j.jcde.2014.11.004

[64] Patel, R. & Davidson, B. (2015). *Forskningsmetodikens grunder* (4th ed.). Lund: Studentlitteratur AB.

[65] Paul, M. T. (Nov 2, 2017). Will AR/VR eventually become new general purpose technology?. *Medium*. https://medium.com/@pb_39145/will-ar-vr-eventually-become-new-general-purpose-technology-d0aded03b578

[66] Peddie, J. (2017). *Augmented reality: Where we will all live* (1st ed.). Springer International Publishing. DOI 10.1007/978-3-319-54502-8

[67] Poetker, B. (2019). A brief history of Augmented Reality. *G2*. https://www.g2.com/articles/history-of-augmented-reality

[68] Porter, M. E., & Heppelmann, J. E. (2017). Why every organization needs an Augmented Reality strategy. *Harvard Business Review*.

[69] PwC. (2019). *Seeing is believing*. https://www.pwc.com/gx/en/technology/publications/assets/how-virtual-reality-and-augmented-reality.pdf

[70] Rogers, E. M. (1962). *Diffusion of innovations* (1st ed.). New York: Free Press of Glencoe. OCLC 254636.

[71] Rogers, E. M. (1983). *Diffusion of innovations* (3rd ed.). New York: Free Press. OCLC 644957984.

[72] Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press. http://dx.doi.org/10.1016/j.jmig.2007.07.001 Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory. The Turkish Online Journal of Educational Technology, 5, 14–23.

[73] Saunders, M., Lewis, P., & Thornhill, A. (2012) *Research methods for business students* (1st ed.). Pearson Education Ltd., Harlow.

[74] Schultz, B. (2020). VR, AR and MR will be the most disruptive technologies of the next decade. *For Construction Pros*. https://www.forconstructionpros.com/construction-technology/news/21205827/idtechex-vr-ar-and-mr-will-be-the-most-disruptive-technologies-of-the-next-decade

[75] Schumpeter, J. A. (1934). *The theory of economic development* (1st ed.). Cambridge, MA: Harvard University Press. ISBN 9780674879904

[76] SJ. (2018a). *VägvisARen – ett smart sätt att hitta rätt*. Retrieved 2021-03-20 from https://www.sj.se/sv/om/om-sj/sj-labs/vagvisaren.html

[77] SJ. (2018b). Hitta rätt med SJs nya digitala vägvisare. *Mynewsdesk*. https://www.mynewsdesk.com/se/sj/pressreleases/hitta-raett-med-sjs-nya-digitala-vaegvisare-2474051

[78] Slotte, N. (2018). *'AR Quick Look' makes AR accessible on iOS 12*. Sayduck. Retrieved 2021-04-03 from https://sayduck.com/2018/10/02/ar-quick-look/

[79] Spatial. (2021). *Spatial - how work should be*. Retrieved 2021-05-10 from https://spatial.io/

[80] Statista. (2021). *Augmented reality (AR) and virtual reality (VR) market size worldwide from 2016 to 2020*. Retrieved 2021-03-30 from https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/

[81] Statista. (2018). *Compound annual growth rate (CAGR) of augmented and virtual reality (AR/VR) use case spending worldwide from 2018 to 2023*. Retrieved

2021-05-11 from https://www.statista.com/statistics/1012881/worldwide-ar-vr-spending-use-case-cagr/

[82] Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage Publications, Inc.

[83] Summerson, C. (2014). What are the ARCore and ARKit Augmented Reality frameworks?. *How to Geek*. Retrieved 2021-03-05 from https://www.howtogeek.com/348445/what-are-the-arcore-and-arkit-augmented-reality-frameworks/

[84] Taylor, M. & Taylor, A. (2012). The technology life cycle: Conceptualization and managerial implications. *Int. J. Production Economics*, *140*(2012), 541–553. http://dx.doi.org/10.1016/j.ijpe.2012.07.006

[85] Zade, A. (2020). What Apple's investment in Augmented Reality means for businesses. *Threekit*. https://www.threekit.com/blog/apple-ar-for-businesses

[86] Utterback, J. (1994). *Mastering the dynamics of innovation* (1st ed.). Harvard Business School Press. ISBN 9780875843421.

[87] Utterback, J., Suarez, F., & Fernando, F. (1993). Patterns of industrial evolution, dominant designs, and firms' survival. *Research on Technological Innovation, Management and Policy*. 5.

[88] Van Der Velden, S., Nasiri, M. N., Noorderhaven, N., & Akkermans, H. (2019). Incumbent success in the era of Ferment: The selection of the next Generation of Technology. *Academy of Management Proceedings*. 18560. 10.5465/AMBPP.2019.18560.

[89] Ward, W. H. (1967). The sailing ship effect. *Bulletin of the institute of physics and physical society*, *18*(6), 169. DOI:10.1088/0031-9112/18/6/004

[90] Wilhelmsson, W. (2017). PostNord fixar augmented reality i sin app till iOS. *Feber*. https://feber.se/mac/postnord-fixar-augmented-reality-i-sin-app-till-ios/373284/

[91] Wilson, M. (2020). What is a LiDAR scanner, the iPhone 12 Pro's camera upgrade, anyway?. *Techradar*. https://www.techradar.com/news/what-is-a-lidar-scanner-the-iphone-12-pros-rumored-camera-upgrade-anyway

[92] XM Reality. (2020). *Remote support for the energy industry*. Retrieved 2021-05-12 from https://xmreality.com/insights/industries/energy/

[93] XM Reality (2021). *XMReality remote guidance*. Retrieved 2021-02-05 from https://xmreality.com/

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Appendix 1: Interview Guides

Interview Guide 1

Listed below are questions that were asked during the semi-structured interviews with companies and its representatives with insights in the industry of Augmented Reality and its related technologies and research.

Interviewees

Anders Baer, Product Development Manager at Telia Company
Christian Josefsson, CEO at Uptive
Christian Rosengren, Sales Executive at Siemens
Fredrik Löfgren, CEO at Around the Corner
Göran Solback, Digital Enterprise Sales at Dassault Systemes
Jenny Arnesson, Global Workflow Consultant at Ascom Wireless Solutions
Johan Nordling, Pre Sales Account Development Team Lead at Siemens
Johan Norrman, Director R&D Platforms at Ascom Wireless Solutions
Marcus Holgersson, Associate Professor at Chalmers University of Technology

Questions

To what extent do you work with AR technology today?
What are primary areas of usage?
What is the response from customers?
Is the technology actually creating value, or is it simply nice-to-have?
What barriers do you consider to be most prominent among customers for adopting AR?
What do you think about the future of AR?
Assuming AR/VR to be widely used among society in the future, how would you consider your business models to change?

Interview Guide 2

Listed below are questions that were asked during the semi-structured interviews with product- and sales oriented companies and its representatives.

Interviewees

Anders Welander, CEO at GoSales
Annelill Annvik, CEO at Gafs Kartong
Engin Hassamanci, Senior Industrial Designer at Farm Product Development
Johannes Palm, Sales Manager at Awake
Peter Hedihn, Production Manager at Ullman Dynamics
Stefan Johansson, Purchase Manager at aPak

Questions

How does your design/sales process look?
How has the process changed over time?
What challenges do you face?
To what extent do you work with technology in your everyday business?
Do you feel that your organization is willing to adopt new technologies?
What digital tools are you using today for communication and collaboration purposes?
What are the main benefits with these solutions?
In what cases would you consider them to be non sufficient?
Are you familiar with AR technology?
Can you see any benefits from using AR in your organization?
What barriers would you consider exist if implementing AR into your organization?

Interview Guide 3

Listed below are questions that were asked during the semi-structured interviews with representatives of Mixtive.

Interviewees

Magnus Willner, CEO at Mixtive
Filip Fatic, Software Developer at Mixtive

Questions

What have been the main challenges when working with AR Call?
Do you think that the scope of the project has been clearly defined?
What has been working well throughout the project?
What would you have done differently?
What do you think about working with AR technology compared to other development projects?
What do you think about the future of AR?
What do you consider to be the main challenges for AR?

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