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The future of smart glasses:
An essay about challenges and possibilities with smart glasses

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This paper discusses the different issues that arise in conjunction with the development of smart glasses, e.g., Google Glass. It is a conceptual and theoretical essay that discusses whether smart glasses will be used and how they might be used. It demonstrates how different problems need to be addressed in the near future, e.g., problems with social interaction, psychological issues, technology development, legal and eye issues and questions of retail. It concludes by outlining the pros and cons of smart glasses as they are.

1. INTRODUCTION

Smart glasses are products that are mounted on the head like normal glasses. They provide the user with information and technological possibilities, e.g., to take pictures or record video. Glasses as we know them today – with frames that go behind the ears – date from the late 18th century (Gans, 2014). Even though laser operations and contact lenses are readily available today, there are still many people who wear glasses. Before prescription glasses became commonplace, they were an object of great attention and a certain nervousness about what they could do. For medieval man, the magnifying and reducing properties of glass were magic, just as today many outsiders regard digital possibilities as something magical. The question is: how will smart glasses be received in society and by people in general and, thus, how will smart glasses fit into the social interaction when they become mainstream? This will be discussed throughout the essay.

Smart glasses are an optics technology based on a *Heads-Up Display* (HUD), a *Head-Mounted Display* (HMD) and, in particular, an *Optical Head Mounted Display (OHMD)*. In brief, there is a plastic object at eye-level, through which the user can see both an online, digital world and an offline, physical world (Kress & Starner, 2013). It is, roughly speaking, like having a smartphone attached to the face. However, unlike the smartphone or other *wearables* (Pentland, 1998) and body-integrated technologies, which require the user to look down or away, smart glasses allow one to look straight out at the world without having to rely on the use of one's hands. This provides a completely different interaction situation and radically new applications.

In the beginning of 2015, Google will probably be launching Google Glass to a wider public. There are already other products on the market, but the *hype* about Glass suggests that, in the long run, we may be talking about a *game changer*. So, what are the opportunities and threats? This question will be answered throughout the essay and summarized in the conclusion. The essay is not exclusively about Google Glass (for short, Glass or GG) but more generally about smart glasses. However, as Google Glass is the most well-known, hyped and the one I have been trying out, the examples will typically be from Glass experiences and reflections.

The essay begins with reflections on the methodological approach (2.0) and, then, moves on to a brief history of wearable technology (3.0). Then, I discuss whether the technology might be used

(4.0) and by whom (5.0) after which I focus on the challenges and possibilities in different fields such as product category, eye issues (6.1), privacy issues (6.2), technology development (6.3), historical, sociological issues (6.4) and interactional and psychological issues (6.5). The essay is concluded by a brief summary of pros and cons with smart glasses (7.0).

2. METHODOLOGICAL APPROACH

This paper addresses a number of issues that need to be considered in the near future. The research has been conducted through a review of the literature in combination with expert interviews and scientific reflections. The paper does not present analysis but reflections and open questions within a range of different disciplines. The paper is, thus, a series of state-of-the-art descriptions of issues that need further investigation in the future. The research that has informed this essay is, in part, a trend analysis based on a variation of the "environmental scanning" method (Martino, 2003), which has similarities with the "competitive technological intelligence" approach (Ashton & Klavans, 1997; Coates et al., 2001), and, in part, based on self-reflecting ethnographic methods (Alaszewski, 2006) as well as on conclusions and hypotheses from micro-analytical multimodal interaction analysis of people using Google Glass in authentic situations (Due, 2014a, 2014b, 2014c).

3. A BRIEF HISTORY OF THE DEVELOPMENT OF WEARABLES

A great part of the development of human civilization has involved a technological evolution towards better, more efficient tools: from the first flint axe and the agricultural tools of the Middle Ages to today's high-tech products. Ideally, the driving force lies in optimization, improvement and efficiency. Early examples of the fusion of man and machine include the first attempts to fly, the design of various kinds of prostheses, and extended installations such as attached weapons, armor and gear (Bijker, Pinch, & Hughes, 2012). However, it is only with the development of the computer that we really see technology merging with human beings. This has predominantly occurred in sci-fi writing, computer games and early films, such as *Star Trek*, *RoboCop* and *Terminator,* among others. These films showed not only the fusion of man and machine but also the possibilities of accessing an extra digital layer of information on a human scale (Graham, 2002).

In addition to experiments in fiction, there has for a long time been a handful of researchers and laymen with an interest in technology, who have experimented with attaching computers to their

bodies. Most prominent, of course, is the team at MIT with Steve Mann and Thad Starner (Starner et al., 1997).

Over the last 20 years, computers have developed from stationary computers, via laptops, to the computers that the user can carry around constantly, also named *wearables* (Dvorak, 2010). This development has led to one revolutionary, new product category on the market after another. In the future, this development will approach total integration with intelligent clothes, intelligent contact lenses, and the incorporation of computers in the skin.

Illustration 1: Timeline for the development of the computer.

In relation to the development of wearables, a synchronous, online and offline world is starting to *converge*, because people want technology that allows them *simultaneously* and in *real time* to be present in the *physical world* while being able to read and produce digital information from and for a *virtual digital world* (Lord, 2013). This is largely made possible by the technological development of computer processes that are becoming smaller and smaller (Brock & Moore, 2006).

The impact of this development is already visible today – now that young (and old) people publicize their lives on Facebook, Twitter and Instagram. Smart glasses, which do not require users to look down or away but present information right in front of their eyes, allow them to publish exactly what they see when they see it. This will probably reinforce the convergence of online and offline.

It is this phenomenon, broadly speaking, that generates a vast range of opportunities and challenges. It will become simultaneously easier and quicker to assist and survey, to entertain and objectify, and document everything, for better and for worse – e.g., there have already been reports about Google Glass Internet addiction disorder (Yung, Eickhoff, Davis, Klam, & Doan, 2015). So, the big question is: how will people relate to these new intelligent products? This is clearly hard to predict, but I will try throughout the essay to discuss those issues that are most important in relation to use and acceptability. First, let us reflect on whether people might use them at all.

4. WILL PEOPLE USE THE SMART GLASSES?

There is something in the air, as Malcolm Gladwell says about emerging technological developments (Gladwell, 2008). The premise is that society, technology, culture and business ambitions merge in a common evolution, which leads to products becoming a natural part of the lives of ordinary people and not just of a few early adopters. This *tipping point* is the right product at the right price and the right marketing at the right time (Gladwell, 2002). And, according to Rogers' *diffusion of innovation* theory (Rogers, 1983), four main elements influence the spread of new ideas: the innovation itself, communication channels, time, and a social system – which is unmistakably a complex matter. Within the rate of adoption, there is a point at which an innovation reaches critical mass or the tipping point in Gladwell's terminology. This is when there is a transition from the *innovators* and *early adopters* to the *early* and *late majority*. At the moment, the technology is still in an innovation or, perhaps, early adopters phase. The development with respect to the innovation itself, the communication channels, time, and the social systems will determine the future.

However, if one takes a look at Gartner's *hype cycle* (2014), *Wearable User Interfaces* are at the top of the hype but with a timeline of up to 10 years until they become widespread. According to the logic of the cycle, the hype around the products will hit a moment of disillusion before the products achieve a wide application.

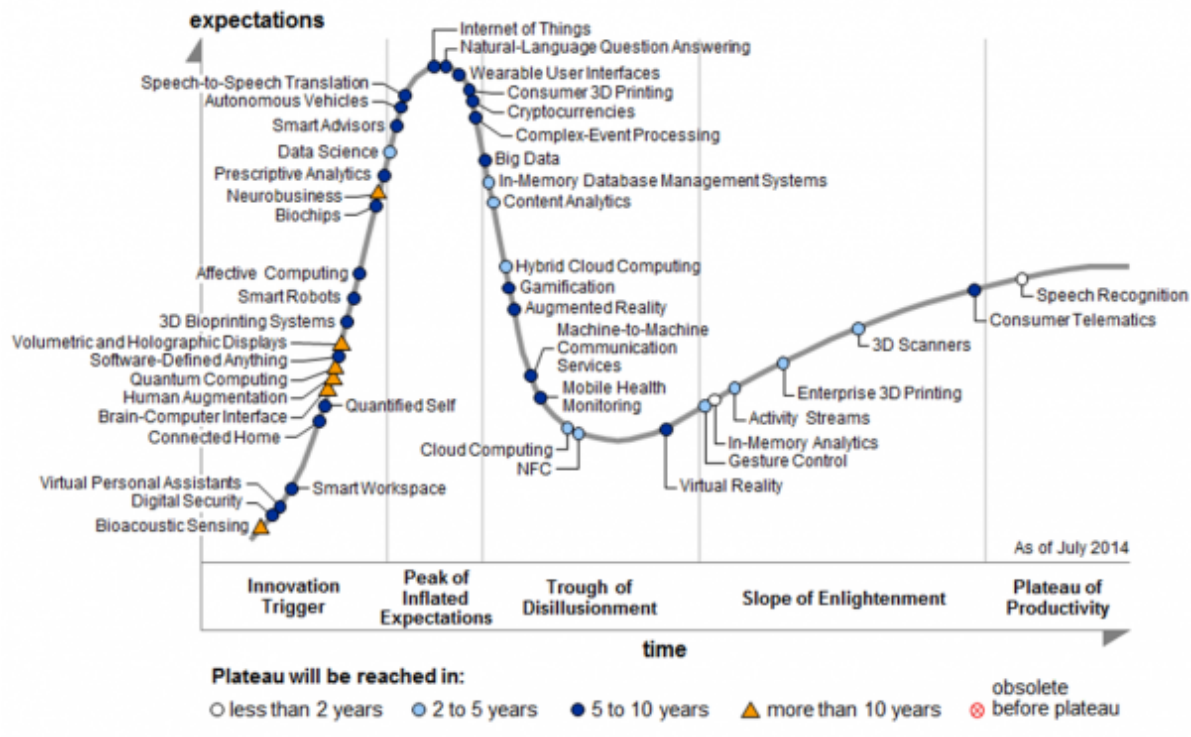

Illustration 2: Gartner's hype cycle 2014

However, most commentators believe that development will take less than 10 years. When Google Glass hits the market in late 2014, the most likely scenario is that a large number of prime movers, early adopters or lead users (Hippel, 2006) will buy a pair of glasses immediately. Within the next 3-5 years, there will probably be a solid market for the sale of smart glasses of some kind – probably not the Google Glass design we know today.

BI Intelligence (Danova, 2013) predicts that 22 million glasses will be sold on the world market by 2018. And a survey by LoveMyVouchers (n=1132) (2014) concludes that, *today*, 68% would not feel comfortable using smart glasses when talking to other people, leaving 32% who actually do not feel that way (in interviews). Other studies from Glass Almanac show that, at the moment, 12-15% of American consumers would be willing to buy Google Glass, if the cost was $750 (Braaten, 2014). This survey also shows that the target group consists mainly of young men between the ages of 18 and 34.

Conversely, there is a strong tendency in technological development for the first version of a product to enjoy only sporadic success and for the next version or a subsequent product, a so-called

fast second, to achieve the actual success (Markides, 2005). This is one of the reasons there is frequently a phase of disillusion, as illustrated in Gartner's hype cycle. But Google has managed to get around this development tendency by launching a beta model in both a 1st and 2nd version before commercialization on a broad market. It is, therefore, very likely that Google Glass, in some shape or form, will still be on the market in 3-5 years' time. However, it is difficult to predict consumer behavior.

5. WHERE AND BY WHOM WILL SMART GLASSES BE USED?

There are generally three types of initial applications for smart glasses: 1) specific job-related applications, 2) task-related and professional, contextual applications and 3) lifestyle applications for so-called *self-trackers*. These three areas will be presented below.

5.1 JOB-RELATED APPLICATIONS

It has become apparent that there are several task- and job-related functions that make sense on an intuitive level because smart glasses let the user use both hands. These functions include the projection of instruction manuals, road maps, and various other similar resources at eye level, while professionals, for example, are engaged in extinguishing fires, pursuing criminals, operating on patients, etc. Smart glasses may also enable others to see what the user is seeing. So, it is not just a question of accessing necessary information: an instructor who sees what you see can also guide you through a process.

Apps are also currently being developed to tell the user where he/she is, because it can recognize the environment of the neighborhood, the inside of the house, etc. This will be of use to people who suffer from cognitive disorders: e.g., Asperger's syndrome, Alzheimer's or blindness. The potential in the healthcare area is significant (Monroy, Shemonski, Shelton, Nolan, & Boppart, 2014).

5.2 TASK-RELATED APPLICATIONS

We will probably also see a number of task-related applications, which resemble job-related applications but take place in the private sphere. This means applications that are involved in specific tasks that could be accomplished more efficiently with the use of smart glasses: e.g., instructions for a DIY enthusiast building a home extension or as a way of filming and documenting certain important life events such as a ride on the Big Dipper, a first dive from the 5-metre diving

board or video communication over long distances. Other obvious niche areas are sporting activities such as running and cycling (Sörös, Daiber, & Weller, 2013).

5.3 LIFESTYLE APPLICATIONS

In addition to the direct applications, which tackle specific problems, smart glasses are also useful in terms of a wide variety of lifestyle applications for people who are today known as *quantified selfers* (QSers) (Due, 2013). These people are characterized by their "need" to measure their behavior. This is expressed in technology, which measures and correlates self-reported or self-measured data and gives people access to an instantaneous understanding of their state.

There is already an enormous amount of technology and programs on the market to measure sleep, motion, food and body signals such as blood sugar, heartbeat, blood pressure, etc. Combined with social media, where one can share one's status, smart glasses could play a special role because they equip one to document life as it is lived even more. This is also known as *life logging* (Mann, 2014).

The group of people who think about, document and share their lives has increased at the same rate as the technological development. There is no indication that the group will get smaller. The "need" to document and show how much exercise one has done, how many fun experiences one has had, and how much good food one has eaten is a trend that is only in its gestation period (Nissen, 2014). So, we can also assume that smart glasses will enforce and create synergy when it comes to life logging in different ways.

Thus, there are definitely opportunities and a market for smart glasses. But there are also many challenges lying ahead. Let us now discuss some of these.

6. CHALLENGES LYING AHEAD

There are many challenges for this kind of technology. One of the key questions to begin with is what product category smart glasses belong to (Tedlock, 2013). Most people agree that this is an entirely new category, similar to when the iPad (tablet) came on the market. There was a great deal of criticism to start with, but the need and the field of application appeared gradually afterwards. In terms of product category, it will be essential to answer the question: to what degree are they

glasses with the same functional and aesthetic qualities as regular glasses or just a computer device/wearable?

In addition to challenges regarding the product category, there are physical, cognitive, social, psychological and technological issues. These issues will be discussed below.

6.1 CHALLENGES WITH EYE EFFECTS

One potentially problematic issue is the effect of smart glasses on the eye and the body as such. Smart glasses are wearable computers; but, unlike all other wearables, the technology is fixed in front of the eye and, thus, adapted to the eye's properties. Apps are being developed that enable one to use the glasses to look at things in order to control them. This is possible because some of the glasses (e.g., Google Glass) can recognize eye movements and, thus, the viewing direction. So, the potential for managing and controlling the outside digital world through the eye is vast. But a number of professional, optician-related questions arise.

In the 1970s, one of the pioneers of wearable technology, Steve Mann, found that intense use of his prototype smart glasses led to disturbed vision. Mann learned that, when he (also) saw the world through the video lens attached to his helmet, it subsequently disturbed his normal vision. The camera's position in relation to the eye is crucial; and, right now, no one knows what the effects of prolonged use might be. Mann experienced dizziness and difficulty with concentration (Mann, 2013b).

For some time now, researchers in the field of virtual reality glasses have been investigating how normal vision and behavior are affected by the prolonged use of eye-sensitive technology, and they have found that the brain and the eye adapt quickly and, therefore, might be affected by prolonged use (Mann, 2013a). The same might be the case with prolonged use of smart glasses (Ackerman, 2013).

More generally, there is a risk of Computer Vision Syndrome (Blehm, Vishnu, Khattak, Mitra, & Yee, 2005), which results from looking for a long time at a point closely in front of the eye. If the eye is tense for a long time, the eye muscles become locked and cannot relax again for some time. The result may be visual disorders, and long sight becomes weak. Google Glass hired Eli Peli,

Professor of Ophthalmology at Harvard Medical School, to help design the technology, so that these and other possible eye problems might be avoided. But, as things stand today, there are numerous unanswered optical questions.

Another relevant problem is the asymmetrical technological design in which only one eye is subject to digital impact, which is the case with Google Glass but not every type of smart glasses on the market. The consequence is that one eye is focused on a specific point in front of the face while the other eye's focus shifts between fixed points in the surrounding. This asymmetry can directly affect the eyes – a condition also known as *phoria*[1].

However, asymmetry is not only about the different foci with which the muscles of the eye have to cope but also about the different content that the brain must interpret and understand. This is known as *binocular rivalry*: the competition between the diverse visual impressions that the brain has to process. It can potentially create forms of cognitive dissonance and discomfort of various kinds (Patterson, Winterbottom, & Pierce, 2006).

How the eye is affected by the technology is, thus, an unresolved question. A completely different field, which also has a lot of unresolved questions, has to do with issues of privacy and data security. This will be discussed in the next section.

6.2 CHALLENGES WITH LAW AND DATA SECURITY

As digitization increases, it becomes easier for everyone to monitor each other. One of the main barriers against the sale and use of intelligent glasses is, undoubtedly, people's discomfort with the idea of constantly being able to be filmed and uploaded onto the Internet – possibly, for commercial use or deployed by countries in their surveillance. With regard to this discomfort, there are several points.

First, it is still quite unclear, in terms of the present legislation in both the USA and Europe, what the attitude is to smart glasses and the possibility of constant, video-filmed surveillance. In fact, this phenomenon has been given its own name: *Sousveillance* (Mann, Nolan, & Wellman, 2002), which

[1] A phoria is a latent deviation, or misalignment, of the eyes that is only apparent some of the time. A phoria appears when fixation on a single object is broken and the eyes are no longer looking at the same object (Bedinghaus, 2014).

is not so much about being monitored from the top but by like-minded people: person-to-person monitoring. This English/French term *Sousveillance* is an alternative to *Surveillance* and means "to look from below" rather than "to look from the top".

Currently, Google has announced that they will not develop facial recognition programs, but commentators believe it is only a matter of time before apps come on the market. Facebook has already progressed quite far with face recognition (the *DeepFace* program), and Google Glass will also soon be able to identify people (and their relationships, geography, age, etc.). This is a serious challenge to any kind of *privacy*.

The key regulatory issue is, in part, about whether and how it is legal to be filmed without being aware of it and accepting it and, in part, about how data will subsequently be stored and who has access to that data. Video and photos taken with Google Glass are tied to Google accounts, such as Gmail and Google+, and any data is uploaded to Google's servers, so that Google has access to that data. Therefore, a number of critics suggest that Google's greatest interest is not so much in selling "a pair of glasses" as in becoming the all-powerful IT infrastructure in which Google owns data about every aspect of our lives (Morozov, 2013).

This would mean that Google could potentially sell this so-called *big data* information in a commercial context and to states, which could begin to predict our needs and, possibly, illegal behavior. Services in Google, such as Google Now, can predict user behavior: e.g., by reading calendars and email and by correlating the information with e.g. news, time and geography. This makes Google the potential "operating system for our lives" (Ahmed, 2012) - which is only boosted by Google Glass. There is still a need for new interpretation and the development of detailed legislation for these new technologies.

Nevertheless, when the first hand-held, analogue cameras came out on the market, they were met with the same criticism. At that time, people demanded that they should be banned, for example, on beaches. Today, there are already many other options for the same type of behavior: e.g., cheap, anonymous small cameras one can hang around one's neck or put on one's clothes, so no one can see them. Basically, the broad issue of surveillance and digital development is not something that relates specifically to smart glasses (Hon, 2013; Clepic, 2013) but generally to technological

development and the vast quantity of digital footprints that almost everyone currently leaves behind (Atrey, Kankanhalli, & Cavallaro, 2013; Kitchin, 2014). Soon, for example, we will also see small drones flying around with (surveillance) cameras. New, relevant legislation needs to be developed across nations.

However, much more basic legal questions have already arisen in the form of specific situations in which the glasses have been banned. This applies particularly to traffic for which the first fine for driving with Google Glass has already been issued to a woman in California. Furthermore, in several American bars in Silicon Valley, Google Glass has been banned: e.g., at the 5 Point Café and Press Play Bar. Thus, it is not a purely legal matter, but the cases show a need amongst people to avoid potential sousveillance. Other places in which the glasses could be banned include casinos, cinemas, concerts and, perhaps, workplaces and similar locations, where the possibility of cheating and deception becomes too large. In many ways, this development has consequences for technological development and design. This will be discussed in the next section.

6.3 CHALLENGES WITH PRODUCT DEVELOPMENT

Much of the technological development in the field of computer science today is about removing the computer from people's immediate consciousness. It is referred to as *pervasive computing* or *ubiquitous computing,* which is about giving the computer a secluded, yet still all-pervading role in the lives of users (Hansmann, 2001). Whenever critics talk about sousveillance and *privacy*, proponents refer to the *empowerment of the individual*. In this light, it is also clear that technological development is progressing in several parallel directions.

First, the technology and its functions must be sufficiently useful, operational and user-friendly and have at least one so-called *killer app* before users will make use of them (Downes & Mui, 2000). In the case of Google Glass, it will probably be the digital layer (*augmented reality*) (Starner et al., 1997) of road maps and instruction manuals that prove to be of most value to start with (Smith, 2013). But several commentators emphasize that the functionality and usability of Google Glass are still too minor for the consumer to experience that she/he is getting value for money. On the big plus side, smart glasses are easier to access than, for example, telephones. The use of technology is subject to a so-called *2-second rule*: the use of a function decreases dramatically if it takes longer

than 2 seconds to find and activate it (Starner, 2013a, 2013b). The glasses are in the process of breaking this barrier down - at least, if one is wearing them.

Like all other technologies, the glasses must solve a problem the user has in a more intelligent, cheaper, simpler or more convenient way. The killer app does not have to be a technological "innovation" but a behavioural innovation. For example, can the user navigate better in traffic? Is it easier to take pictures or to see one's calendar? Are there any financial, social or emotional benefits? These issues will properly determine how the technology will develop.

Second, the issue of aesthetics and design is absolutely vital. Glasses are jewelry for the face, and they play a major role in creating a user's specific visual appearance. In terms of design and form factors, people claim that *wearables* should either be stylish and beautiful, giving off the right signals or, alternatively, completely invisible. Since most intelligent glasses at the moment are far from invisible, the former is the case. Like all other visible accessories and clothing, glasses are part of a person's public image. The same goes for smart glasses, which are also (very) visible identity signifiers, which make a definite statement about the person wearing them.

Many of Apple's revolutionary products, for instance, were successful because of this identity-signifying effect: users want to show off their latest iPod, iPad, iPhone and MacBook. This coolness factor is a key driving force in the development of technology. But, as things are now, smart glasses in general and Google Glass in particular are getting a lot of criticism along the way. Meanwhile, on Tumblr, there is a whole new category known as "white men wearing Google Glass" with countless photos of "nerds" with Google Glasses. Many commentators compare it to walking around with a Bluetooth headset on: something only "maladroit" people do outside a work setting. In purely design terms, this has led to the so-called *bluedouche principle*, which refers to the development of a smart product that is not cool and lacks relevance to everyday life (Wasik, 2013).

Google Glass has obviously identified the challenge and has launched a series of fashionable designer glasses, which are compatible with Google Glass. They have, for example, signed cooperation agreements with sports fashion brands such as Ray-Ban and Oakley. This may also release it from what some people have called *the trucker hat principle* (ibid.), which refers to a certain mesh cap that "everyone" wore at one time. When everyone wears the same thing, it is no

longer unique and identity-creating. If, all of a sudden, everyone runs around with exactly the same design and color of glasses, then this becomes a challenge to individuality. This is especially problematic in the present era of individuality.

Bearing in mind these design reflections, it is also possible that smart glasses will become a kind of transition phenomenon on the way towards less visible wearable computers (*ubiquitous computing)*. In this regard, there are a number of products on the market and in development: smart contact lenses, smart hearing aids and smart clothes, which could ultimately have the same capabilities as smart glasses. But we are talking some time ahead. Meanwhile, Google Glass is already relevant in 2014.

However, the interesting issue is the combination of functionality, user-friendliness and fashionable design, which along with price represent the driving force in terms of technology development. There are indications that the development will focus strongly on specialized areas in which special medical needs can be handled in new ways: so-called welfare technologies. This applies, for instance, to the use of glasses in hospitals and to developments in the field of smart contact lenses in which functionality is more specifically linked to tasks such as measuring blood sugar in the tear ducts and, then, transmitting the data via wireless media (Narain, 2014). Still, the development in many ways depends on the critical mass and acceptance of the product. This will be discussed in the next section.

6.4 CHALLENGES WITH TECHNOLOGY ACCEPTANCE

From a historical and sociological perspective, the history of technology tends to repeat itself. Every time new products are launched on the market – especially, new product categories, they are greeted with amazement and criticism. Even Socrates (Plato) lamented the invention of written language because he imagined that written thoughts would stop people from using their heads to remember things (Plato, 1925). When the wristwatch was invented, people were dismayed at this strict time controlling of life that prevented the senses from working. When the tractor was invented, people were sad about the disappearance of the Romantic farmer and his horse. Etcetera.

Today, we talk about *the Walkman effect* (Hosokawa, 1984), because in its day the Walkman actually encountered a lot of criticism from the man on the street. On one hand, people thought that,

in aesthetic terms, it was just plain silly to walk around with big headphones on one's head. On the other hand, they considered it profoundly antisocial to wear them in public. *The Walkman effect* is relevant to smart glasses because they also represent a new, different and visible element on the head, which can control mental impressions. So, it is not entirely surprising that the same issues crop up.

People who have already used smart glasses for a while report a series of remarkable experiences: they are stopped on the street, they are met with interest, and people ask if they may try them on. On the other hand, the Glass users are also met with criticism and anger, and people ask them to take them off. The glasses create a lot of attention, which has led to what has become known as the *Glasshole effect* (Due, 2014a). *Glassholes* are people who do not follow this or that diffuse social etiquette for using the new smart glasses. They are often seen filming and taking pictures of people and publishing them online. So, the basic tenet is: "Get that camera out of my face."

Mat Honan, a prominent Google Glass wearer, describes all the difficulties that he, as a first-time user, has encountered in social situations, in that the glasses are "pretty great as long as you are not around other people" (Honan, 2013). But he learned that people basically do not like him when he wears them. These issues will probably change when there are many more glasses on the market. Google is doing its best to create awareness and has developed a social etiquette based on *Do's and Don'ts* and *10 Google Glass Myths* (Google, 2014).

Basically, new technologies and products are always put to use long before the establishment of any new rules of behavior, norms and specific codes of social etiquette (McLuhan, 1964). Thus, the most urgent sociological question is whether and how a new form of behavior regulation and some common moral standards will be developed: in short, a new social etiquette for the use of smart glasses in general. This is still not clear at all (Due, forth.).

When the first smartphones was launched on the market, they were both a class marker and an identity marker. An iPhone is rather expensive, and only the wealthy can afford it. So far, the same is true of Google Glass. They can be looked at as class markers, which differentiate between rich and poor. The worst dystopias, as I see it, draw a picture of "Them versus Us": between cyborgs, who are technologically connected (à la Schwarzenegger in *Terminator*), and "authentic", "real"

people. A cyborg is short for Cybernetic organism, which in popular terms refers to people who improve their abilities with the use of connected technology – also, called *transhumanism* (Farrell & Hart, 2012). Science-fiction examples of this phenomenon include *RoboCop* and *Terminator*, but the term is also used more prosaically and has acquired a new meaning with the advent of smart glasses. There is now an entire organization working to stop cyborgs with smart glasses: stopthecyborgs.org. So, in purely sociological terms, it becomes a question of how smart glasses can and will be demystified over the course of time and what cultural practices will support this process. However, along the way, there are also challenges with psychological, philosophical and interactional issues.

6.5 CHALLENGES WITH PSYCHOLOGICAL, PHILOSOPHICAL AND INTERACTIONAL ISSUES

The glasses move even more the boundaries for interaction between people – boundaries that are currently becoming more and more technologically mediated. For example, many young people today have no problem in listening to music with a single earplug in one ear, while they look at their phone and interact with friends. They are partly present in a constantly augmented reality in which a digital layer of information from a mobile phone flows over physical reality. As new technological products appear, new sets of rules are constantly being debated.

The most realistic form of etiquette will probably be that the user should remove his smart glasses if he is not using them. But there will always be people on the edge of this etiquette – for example, the type of person who will also always use the Bluetooth headset (bluedouchers) and the type of people who are always looking at their telephones, wherever they are. Etiquette often prescribes that this distance is bad form in terms of interaction, but lots of people do it anyway.

When users have the glasses on, they can make themselves relevant as interactive participants, because they are looking up and seem involved even though, in reality, they may actually be involved in some other digital activity. On the other hand, people look down and away, when they use a telephone, thus making themselves irrelevant as prospective speakers. But the difference is more subtle: when using a mobile phone, users turn their heads away completely; when using the glasses, users only move their eyes. In both cases, technology intrudes into interaction (Lyons, 2005).

By turning away their face and gaze, users generally indicate that they are not available for conversation at that particular moment. In this way, the phone has been used as a tool to guard against losing face: the user is never alone and lonely and never devoid of interaction because he/she can always take out the mobile phone and check emails and other "important" matters. The user is never totally "naked" in front of other people; she/he always has the opportunity to save face and insert distance into the interaction. The same kind of face-saving function will also probably be witnessed in the use of smart glasses, producing some kind of new alone togetherness (Turkle, 2012). But this is still to be examined through detailed analysis (Due, forth.).

Just how this will be dealt with in terms of interaction in social situations, time alone will tell. The major etiquette-related issues will result partly from the development of the technology in itself and partly (and substantially) because of the fracture surfaces between the diverse etiquettes of various groups or segments: e.g., the norms of younger generations in contrast to those of older generations.

At the psychological level, it is also a question of how this kind of interaction may affect our ability to empathize. The ability to empathize and insight into subtle social rules and patterns are part of the core characteristics of a human being. Empathy is developed in concert with other people and the physical, intense feedback they provide. In simple terms, empathy is the capacity to notice and understand other people's feelings. The brain is stimulated by new forms of interaction and the use of new technology and, thanks to its plastic properties, the brain can change (Pascual-Leone, Amedi, Fregni, & Merabet, 2005). Some scholars claim that the prolonged use of technologies such as smart glasses, which may possibly create distance from other people, is in danger of reducing our social skills because it stimulates the brain in new ways (Small & Vorgan, 2009).

At the same time, reports claim that, in their encounter with such technology as the Internet and the mobile phone, an increasing number of people are experiencing what is known as *continuous partial attention* (Stone, 2014). The premise is that the brain has become used to rapid sources of information reward. The result is that the brain adjusts to being in a constant state of stress – seeking new information/stimuli. This triggers adrenaline, which provides renewed energy in the short term but, in the long run, can lead to depressive states because the anatomical areas that control emotional states are attacked by stress hormones. It is very likely that some of the same

issues will be recreated and gain renewed vigor when or if people in the future constantly walk around with smart glasses, cf. Google Glass internet addiction disorder (Yung et al., 2015).

There is also the question of what significance the minimization of people's tactile experience of the world, which comes from the sense of touch and handling of material objects, will have when and if we no longer touch technology in the same way. Other major philosophical questions that will arise in the near future are: what are the limits of the human being in terms of adaptation to technology (e.g., the limits of the skin), and what type of antisocial human being may possibly evolve (so-called solipsism, the theory that one's own existence is the only thing that is real). Other philosophical viewpoints talk in terms of mirrors, windows and prisms. Are the glasses a mirror to the world or a window through which you can look into the world of the user? In this context, it might be appropriate to view the glasses in relation to religious-historical myths about psychic seers who can look into the future and other places in their crystal balls. This may say something about the human need to look in the glass to see more than just the present.

7. CONCLUSIONS

In this essay, I have tried to discuss the possibilities and challenges that arise in conjunction with the development of smart glasses as wearable technology. I have tried to outline whether and how the technology will develop and how fast it might become mainstream. It is my guess – although this is "dangerous" – that smart glasses will first hit mainstream in specific institutional contexts such as, for instance, service industries, healthcare and manufacture, and this could happen within 3-5 years depending on further technology development. However, the acceptance and use in social interaction is at the moment the biggest challenge, as I see it. How people in social interaction might want to use smart glasses in meaningful ways will depend on how the input design (talking to the glasses) and hardware such as frames and optics will develop. The adoption of smart glasses by the mainstream population will properly not take place with glasses more or less like the prototypes on the market today. But, in 5 years, the technology and social acceptability will already have changed a lot. The wearable technology will definitely be huge and colonize systems and the lifeworld as we know it; and, in the near future, glasses, watches, devices in clothing and, perhaps, incorporated into the skin will be completely normal, like the Internet and smartphones are today. The technology will certainly evolve and arrive with unimaginable products, and everyone will

need to reflect on the big issues such as social interaction and psychological well-being, eye issues and legal and privacy issues.

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