Analysis of the Failure of Google Glass: Google's wearable augmented reality device

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

In 2013, Google introduced a transformative wearable device projected to disrupt the status quo of how consumers interact with technology: Google Glass. Google Glass is an optical head-mounted display resembling eyeglasses that combines the functionality of a wearable computer with augmented reality (AR) features (Sharma, 2018). Glass wearers could simply swipe the touchpad on the side of the headset or use voice-control activation to access digital content such as text messages, emails, and navigation directions superimposed on their physical surroundings. Despite the leaps of technological advancement made by Google Glass, Google announced that it would stop prototype production due to underperforming sales and poor consumer reception by 2015 (Edwards, 2015).

The recall of Google Glass was attributed to several factors, including consumer privacy concerns, unattainable costs, and poor aesthetics. Several businesses and institutions prohibited the use of Google Glass because of concerns regarding its recording capabilities, which could inadvertently capture individuals without their consent; this movement reflected a societal rejection of the device (Liao, 2016; Weidner, 2023). While these factors are commonly associated with the failure of Google Glass, a contributor often overlooked is the role the designers' misguided ideas and assumptions about users played in the product's demise. Exploring both the software and hardware features engineered for Google Glass can help identify the ideas and biases about users that were embedded into its design. It is critical to understand how the Glass project leaders' unfounded notions about users impacted Glass production to navigate future projects that similarly reform our relationships with technology, mitigating risk and discomfort to consumers through user-centric design.

I maintain that the manifestations of the end-user biases in Glass' design largely contributed to the public's discontent towards the technology, and that creators of Google Glass held the assumptions that users 1) prioritize technology as a component of themselves and 2) are reliant on digital connectivity. To support my argument, I will draw upon Woolgar's theory of user configuration, which states that user interactions with technology are constrained by the beliefs engineers reserved about users that are ingrained within the design. I will also analyze evidence from primary sources such as media articles from the time of product release and Google's marketing materials for Google Glass, including promotional videos, advertisements, and reviews of online content creators.

Background

Google Glass was first introduced at Google's 2012 annual developer conference as an Augmented Reality (AR) device, defined as technology that combines three-dimensional, interactive digital graphics with a physical environment (Liao, 2016). Built with a portable form factor as a headset/ glasses frame, the hardware consisted of a capacitive touchpad controller located on the right arm that recognized voice commands via 3 built-in microphones. The right lens also connected to a prism-like screen for image projection and 5 megapixel still/720p video camera allowing wearers to stream a real time feed with 83 degree field of view from their perspective (Noah, et al., 2022). Around the time of Glass' release, other players were entering the Extended Reality (XR) space as well; these include the Oculus Rift DK1, a Virtual Reality (VR) headset for immersive entertainment introduced in 2013, and Microsoft's Hololens offering a Mixed Reality (MR) productivity tool for frontline workers in 2015.

Literature Review

Due to the shock value of Google Glass' entrance to the market as a first-of-its-kind smart device, there have been numerous studies assessing its potential value in various professional environments. Other scholarship participates in media discourse on the moral and ethical repercussions of the product, touching on its sociotechnical influence. However, these studies are mainly focused on the product's reception or application, and neglect consideration for factors involved in the production process – such as the target user assumptions made by the project team – that shaped the development and resulting scientific/societal impact.

In a comprehensive analysis of multiple studies employing Google Glass in different surgical specialties, the device was tested as a procedure assistance, documentation, and educational tool. Some research used it as a portable ultrasound and fluorescence imaging data display for surgical navigation, while others used it mainly to capture videos or photos documenting surgeries and laboratory/patient records. It was also utilized in postoperative procedures like recovery telemonitoring. The main factors the device was assessed on across studies were "feasibility, usability, and/or acceptability by physicians". The study concluded that the Glass had the greatest benefit and lowest risk in applications for surgical education, where the unique first-person vantage point of surgeries proved effective (Wei et al., 2018). The research done affirms the limitations of Google Glass in providing value for the general public, and that the multifunctional, hands-free design is better suited for professionals who have concrete use cases.

The prior study highlights the lack of applications of Google Glass' capabilities for the everyday consumer as a cause for poor adoption. Their argument is supported and furthered by the work of Klein et al., who noted the conflicting interests of consumers and other actors involved in the construction of Glass. They draw upon the Actor-Network Theory (ANT) to

analyze the process of controversy emergence and how it progresses over the innovation process as related to Google Glass. The digital platform innovation process was framed as a process of translation which occurs when the focal actor, Google Glass, initiates the journey of network building. The framework proposed associated multiple points of controversy to each stage of translation. In problematization - the problem proposal process – the authors argue there was disagreement amongst actors over the proposed problem, the solution, and the lack of clarity on the technology value amongst actors. The generativity of Glass made the product's value and intended problem solved unclear. And in Interessment, innovators disagreed on definitions of actor identities and right for participation/co-creation. The unapparent possible uses of Glass' ability to collect data anytime, anywhere caused users to be skeptical of Google's underlying motives with Glass (Klein, et al., 2020). As opposed to the previous work discussing design limitations purely from the functional/technical perspective, this study recognizes human actors, such as Google, as influences to the contention surrounding Glass.

In this paper, I will further the analysis of Google Glass' failure to integrate within society by going beyond the identification of Google's project team as an element of influence. I will extract the designers' ideas of their target users– assumptions of user values, competencies, goals, etc. – and demonstrate how it impacted the smart glasses' production and reception. Examining the discrepancies between the designers' envisioned user for Glass and the actual user informs how the creation and introduction of innovative sociotechnical systems should be executed.

User Configuration

An analysis of the deliberate decisions made by the Google Glass developing team which ultimately led to the product's rejection by consumers will be conducted using Steve Woolgar's

framework of user configuration. Woolgar's theory explores the connection between the production of technology and the subsequent interpretations of its usage. He states that engineers impose limitations on technology based on their ideas, assumptions, and biases about users – which they consciously and/or unconsciously express within the technologies they design (Woolgar, 1990). In developing his argument, Woolgar utilizes the metaphor of the machine as text and the users as readers to demonstrate the complex interplay between technology and users. Similar to how readers can interpret text in varying ways, users also engage with technology differently based on their individual perspective, previous experiences, and expectations. However, when designers configure users by defining the knowledge/skills they assume individuals have, a misalignment of the configured user and actual user may arise.

Woolgar explains his theory through a case study of usability trials with a microcomputer built around the Intel 286 chip called the Stratus 286. The trials conducted with potential end-users revealed that there is much ambiguity in user character and their predicted interpretation of the machine. Woolgar claims "The capacity and boundedness of the machine take their sense and meaning from the capacity and boundedness of the user", in other words the machine's purpose is identified by the relationship to the user (Woolgar, 1990, p. 72). Users can only extract the true capability of a technology given the right context, which is defined by the designers through their social ideas of the user. A clash between the configured user, or the envisioned user, and the real user can lead to performance issues, limited adoption of the technology, and increased need for user assistance or training which is a time-consuming effort.

Employing Woolgar's framework of user configuration, I will analyze the case of Google Glass and its failure to integrate within society. First, I will examine the assumptions made by designers and the subsequent personality that was formed for the configured user. Then, I will

draw parallels between the traits of the designer's configured user and the actual design of the Google Glass to show how their biases manifested in the technology on both software and hardware aspects. Finally, I will describe the character of the actual user based on their public reception of the device to highlight the misalignments between the designer's vision of the user and the real users that ultimately led to the poor uptake of Google Glass.

Analysis

Google Glass, a product once featured in *TIME* magazine's "Best Inventions of the Year 2012" Issue , was discontinued for the general public by 2015 (TIME, 2012). It was later improved and rebranded in 2017 as the Glass Enterprise Edition (EE) which was sold exclusively to companies as a workplace tool (Levy, 2017). Major companies such as GE, Boeing, and Volkswagen enthusiastically adopted the smart glasses, embracing the hands-free, non-obtrusive information display features that produced notable increases in productivity spikes and error reduction. The reception of Glass Enterprise Edition is a stark contrast to the mass rejection of its previously released consumer version. This analysis will draw on the principles of user configuration introduced by Steve Woolgar to reverse engineer the Glass designers' configured user based on the final model of Glass, reveal the exact beliefs designers had about users, how they manifested themselves in Glass' production process, and why it missed the mark for its original audience.

Technology and our Lifestyle

The first major configuration Google leaders imposed onto users was that consumers view technology as a component of themselves, which is demonstrated by the incorporation of a camera component that lacked consideration of non-Glass users' privacy. Glass leaders believed people desired technological facilitation of authentic human interaction, evidenced by Google

co-founder Sergey Brin's justification for the Glass camera in his 2013 TED Conference talk introducing Google Glass:

> Our original prototypes didn't have cameras at all, but it's been really magical to be able to capture moments spent with my family, my kids. I just never would have dug out a camera or a phone or something else to take that moment (Brin, 2013).

In Brin's statement, it is important to note he mentions the camera component's primary value is the ability for users to document moments of candid human activity. This illustrates the Glass team's perspective that recording others with technology can be equivalent to observing with one's own eyes, revealing their assumption that all individuals have accepted technology's presence within every aspect of their lives.

The designers' overly optimistic estimate of the users' comfort toward technological injection within daily life is also reflected by the insufficient sensory/feedback signals when Glass is in recording mode as shown in Figure 1 below (Phandroid, 2013).

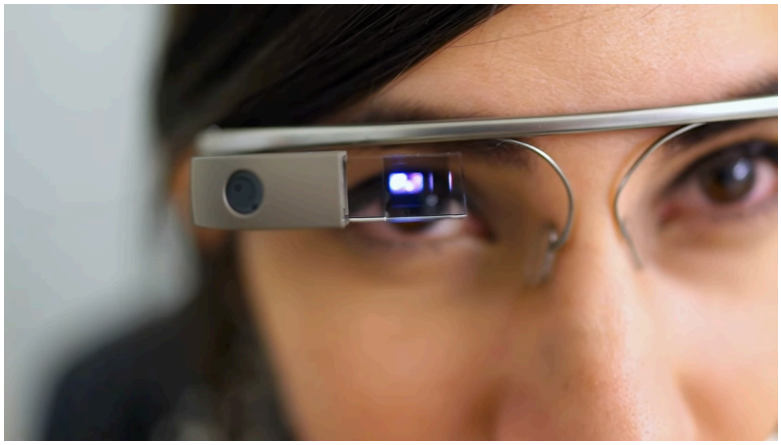

Figure 1. Earlier Version of Google Glass in Recording Mode

The circular camera lens is located in the plastic housing positioned on the upper corner of the right glasses frame. Notably, there is no obvious visual indication – such as a blinking red light most are familiar with on handheld video cameras – that the camera is active. While the prism

light does display the reverse-image feedback of what the user is recording, a bystander would have to be in very close proximity to notice and interpret it as the camera on recording mode. It is so subtle that Steve Topolsky, co-founder and editor-in-chief of technology at technology news provider *The Verge*, could recount a specific instance when wearing the device at Starbucks, where the film crew he was accompanied by were asked to stop recording but his active Glass' camera went unnoticed (Topolsky, 2013). This design decision indicates it was not a priority to incorporate a live recording signal as a courtesy to non-user stakeholders because the Glass team configured the users as individuals with high degrees of technology tolerance.

The cues for initiating recording on the glasses were understated not only in their physical design but also in the prompts used to activate the camera. These methods were 1) using a voice command "Okay, Glass, take a [picture or video]" or 2) tapping the touchpad on the right arm (Stevens, 2013). While the voice command method is more effective at notifying bystanders of the intention to film, its directness contradicts Brin's assertion mentioned earlier that Glass enables the recording of everyday moments more naturally than pulling out a smartphone. Therefore, the most feasible choice to initiate recording is the second method, but to the inattentive observer it is easily overlooked and raises concerns about filming without consent.

While society's values surrounding privacy are constantly changing as technology advances, the designers failed to recognize that Glass challenged public privacy to an unadaptable degree due to their misconceptions about users. As Kudina and Verbeek stated, the product "blurs the boundary between the public and the private in new ways… challenging the messy endeavor of trying to make sense of privacy in the digital age" (Kudina and Verbeek, 2018). By assuming users prioritize seamless integration of technology into their daily lives and view digital interactions similarly to their real-world counterparts, the Glass design team

overlooked the potential impact on public privacy. This assumption led to the absence of a clear signal during both activation and operation of the camera and further built-in risk mitigation methods.

The result of the misalignment between designer and societal expectations produced an ostracizing social experience for those wearing the device. Mat Honan, an author at *Wired* who spent a year with Google Glass, shares a pertinent anecdote: "what was interesting to me in retrospect was I had to work to convince my wife to let me use Glass. I didn't have to convince her I should take pictures or shoot video. It was the form factor of the camera that irked her" (Honan, 2013). Honan refers to "form factor" as the physical appearance and design of a device, which in the case of Glass, elicited concerns about its unconventional and potentially intrusive presence. Honan's example proves that even between individuals who have a relationship, the nature of Glass' camera incorporation still evokes feelings of discomfort from the illusion that it is always watching. This feeling is amplified by the lack of distinction between recording vs non-recording modes. And from the non-Glass wearer's perspective, David Pogue described in an opinion article on *Scientific American* an encounter with a Google employee wearing glass in public; he recounts, "There she was, wearing this creepy-looking, faux-futuristic forehead band—with a built-in video camera pointed at my face. For all I knew, it was recording me" (Pogue, 2013). Pogue's unease was caused by the uncertainty of being filmed, which created a social dynamic that put him in a position of vulnerability and power imbalance with the Google employee.

Instead of realizing the importance of implementing privacy measures in product design, Glass designers focused on creating a fashionable look for the second release of Google Glass Explorer Edition, which allowed users to attach a traditional-looking glasses frame onto Google

Glass (Colon, 2014). A sample of Google Glass Explorer Edition 2.0 is pictured in Figure 2 below (Casey, 2013):

Figure 2. Google Glass Explorer Edition 2.0 with Improved Styling

The new frame resembles a typical pair of sunglasses, minimizing the protrusion of the cyborg-esque tech components. It is evident the creators attempted to blend the technology into society from an aesthetic standpoint, mitigating the problem by masking the power asymmetry of users and non-users rather than admitting and addressing the problem's source. This decision likely resulted from the designers' assumption that society could adapt to a new expectation of public technology use, the same way they have to smartphones, because their configured user already appreciates technology as a central component of themselves.

In the previous section, I have shown that the social rejection of Google Glass was a result of design decisions made by the project leaders based on preconceived notions underestimating the value of privacy and technology from the end-user's perspective. However, some scholars argue that the privacy barriers encountered were entirely a cultural issue rather than design (Eveleth, 2018). Kudina and Verbeek utilized the technological mediation framework – which emphasizes the role of technology in shaping human practices, experiences, and values – in an analysis of Google Glass' sociotechnical impact. Approaching the entrance of Glass into

society using the technological mediation perspective led them to conclude how Glass will shape the practices and experiences of potential users, and that "users will implicitly define specific notions of privacy in anticipating these mediations." This perspective showcases the importance of examining normative transformations during interactions with Google Glass, indicating that the rejection was driven by the necessity to significantly reshape potential users' privacy values and therefore stemming from issues in technology consumption rather than production. However, this view overlooks the resulting need for users to reframe their moral and ethical values around Glass might not have been as dramatic had the creators anticipated societal expectations regarding technology relationships and designed the product to uphold the privacy of both wearers and non-wearers.

To address the oversights regarding transparency in design, Privacy Commissioner of Canada Jennifer Stoddart criticized the insufficiency of camera usage indicators and the concern of data protection authorities towards Glass usage in a letter to Google Inc.

> Fears of ubiquitous surveillance of individuals by other individuals have been raised… data protection agencies have long emphasized the need for organizations to build privacy into the development of products and services before they are launched (Stoddart, 2013).

Stoddart's statement implies that organizations have been more successful when they make privacy consideration a design requirement. Thus, Glass could have been better received by the public if it had incorporated data protection strategies/privacy safeguards before release. The inaccurate predictions the Glass designers made about their potential users' dynamic with technology in their lifestyles led to the poor design choices that hindered the device's acceptance within society.

Overestimated Digital Network Reliance

The Google Glass designers' bias towards a user identity that is heavily reliant on digital access and information is evident in the creation of a dedicated app development method for customized data retrieval, called the Mirror API. In the initial release of Google Glass, developers could build Glass programs (called Glassware) using Google's Mirror API, a service that enabled interaction with web services that Google hosted and managed. Any applications built with Mirror API do not interact with the Glass device directly, but instead have content sent and received from Glass to the web app by the API to run programs purely on the cloud in browser format. In the book *Designing and developing for Google Glass* by software developers Allen Firstenberg and Jason Salas, they describe the Glass in the following manner:

> [Glass is] a self-contained device … not explicitly requiring an accompanying smartphone, but enhanced by tethering to another smart device for network connectivity and for telecommunication services…it's a hand-free, ears-free, and wires-free means of staying connected and interacting with others online (Firstenberg and Salas, 2016, pg.16).

The Glassware developers' explanation emphasizes the increased enablement for "network connectivity" as Glass eliminates the physical constraints associated with smartphones. Therefore, the envisioned user is assumed to be sufficiently dependent on digital information to necessitate heightened accessibility through Mirror API-powered apps.

Interaction designers for Mirror API apps could only execute simple, web-centric applications since data and interactions were handled on Google's servers rather than direct to the device. In contrast, the Glass Development Kit (GDK), which became available a couple months after the Mirror API, allowed developers more granular control of Glassware development as programs that are installed onto the device. GDK was an extension of the

Android programming libraries and allowed developers to access the hardware, like the camera, microphone, and sensors of Google Glass in their programs; offline running was enabled through GDK development as well. GDK applications were overall more sophisticated and device-centric than their Mirror API app counterparts.

The GDK was made available at a later date than the Mirror API due to Google's hesitation to roll out so much development control for a device still in its infancy. Developers were not able to incorporate facial recognition, geotagging, and a formal way to monetize applications (Murphy, 2013). Glass creators' decision to release Mirror API first reflects their confidence that programs built on a simple push-pull of information would provide enough value for users.

By releasing Mirror API first and the GDK with a limited set of capabilities for developers, initial creation was restricted to interactions based mostly on the Glass home page, or timeline. The timeline is a row of cards that appears once the device is turned on, where the user can view information such as the time, weather, upcoming events, and messages. Joe Casabona, author of "Web Designer's Guide to Google Glass," lists examples of Mirror API-developed Glassware:

> In the book, we build a "quote of the day" app that will push a random quote and photo to Google Glass. Imagine that we have another service that pulls the top tweet for a specific hashtag on Twitter every hour. We could use the Mirror API to push that tweet to the user. Apps have already been written to do something similar for headlines, sports scores, and more (Casabona, 2014).

His examples of popular Mirror API Glassware provide small, easily consumable pieces of information that could be similarly read at the single glance of a phone. Twitter hashtags, sports

scores, etc. are inherently minor information with relatively low significance, providing users with supplemental rather than essential updates for their daily routines. By releasing Mirror API as a specific development approach, Glass designers anticipated that their end-users would want the on-demand, consistent feed of customized trivial data. The Glass team was implicitly biased towards a user identity that relied heavily on Google's proprietary digital network, and had a vision aligning with Google's mission for a world where "information would come to you as you needed it" (Brin, 2013). However, highlighting Glass' ability to retrieve snippets of personalized information as a key feature to users and producing a specific development method, Mirror API, for that purpose limited the interaction for actual end-users. The designers overestimated the importance of users' connection to data in their daily lives, leading consumers to conclude Glass offered very little value over their existing devices, like smartphones, that housed the same querying capabilities (Yoon, 2018).

Conclusion

The downfall of Google Glass in the consumer market is often credited to a combination of factors including privacy concerns, unaffordable costs, and poor aesthetics. However, utilizing the user configuration of Steve Woolgar to analyze the deliberate design decisions made by the Google Glass team based on their assumptions of the biases and values of users, has revealed a fundamental misalignment between designers' imagined user and the actual user. These unfounded beliefs are that 1) individuals see technology as an extension of themselves and 2) users are reliant on digital information and find fulfillment from unfettered connection to their digital network. This propelled design decisions such as the lack of privacy features for the camera and a separate development tool, the Mirror API, focused on building apps for users that simply scraped customized information such as live sports scores. The result was mass

controversy over privacy invasion from non-Glass wearers and conclusions that Glass had little value proposition. This analysis highlights the necessity of aligning configured users with not only real users, but any stakeholders who are impacted by the end user's relationship with technology, including non-users. As the Extended Reality market advances, the Google Glass experience serves as a crucial lesson calling for design processes that consider the new identities a user could assume when equipped with the capabilities of the proposed technology. Bridging the gap between designers' assumptions and genuine user expectations remains paramount. The case of Google Glass provides insights into the complexities of introducing innovative technologies into society, emphasizing the need for a well-informed and user-facing approach in shaping the future of human-computer interaction.

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