THE EFFECTS OF WEARABLE TECHNOLOGY ON HUMAN PSYCHE

A Research Paper submitted to the Department of Engineering and Society
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Science

By

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March 27, 2020

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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In the age of a rapidly evolving technological society, humans often allow the changes and admission of new technology to become integrated into civilization without fully understanding their consequences and impact. As consumers, humans only seek aspects of technology that are relevant to their needs and wishes. Therefore, many consumers solely seek what they wish to seek, and often ignore the products' limitations and consequences that do not affect them directly or of lesser importance. However, many unintended consequences of technological advancements can indirectly impact consumers and create bigger problems down the line, as well as leading the user to exhibit attitudes of negligence toward lesser known problems.

The technical project serves to mitigate one aspect of this indifference toward human understanding and promote self-examination about personal prejudices and biases. The Capstone project that measures these preconceptions is the Power of Difference Assessment system, an online web assessment made up of seventy multiple choice questions that asks the users how much they agree and disagree with statements relating to sociocultural cases. The goal of the Power of Difference Assessment is to foster intercultural sensitivity and point out personal flaws within the examiners that limit their own potential and their ability to facilitate economic, social and cultural relationships in different societies. The globalization of economies and culture will continue to develop and force people with different backgrounds to cooperate with each other, thus it is imperative to advance this attribute of intercultural sensitivity. The Capstone team will be in charge of overhauling the outdated assessment system and improve its scalability by deploying the finished product using Amazon Web Services so that at least one thousand users can take the assessment concurrently.

Aside from overlooking the consequences of character development, technological awareness is equally important and one of the many unrecognized harmful effects of technology lies in the use of wearable technology. Using the Social Construction of Technology and System in Context frameworks (Carlson, 2009), the STS Research paper discusses the subtle ways that wearable technologies have transformed from a piece of hardware that serves the user into an entity that governs our way of thinking. This STS Research begins by providing an overview of the wearable technologies' current state of affairs and then addresses how wearables are flawed in the areas of health monitoring and health betterment which will be depicted using the System in Context framework (Carlson, 2009). Specifically, the framework analyzes the disconnect and miscommunication between wearable users and doctors, undermining the goal of health betterment. Additionally, the poor quality of data and information overload presented by current wearable technologies also remains an issue with error margins of up to 25% (Piwek, Ellis, Andrews & Joinson, 2016, para. 7). After emphasizing the ramifications of wearables, the STS Research paper promotes better design decisions that will maximize human prosperity and minimize complications. The new development process will be described by the Social Construction of Technology framework, indicating that social groups such as mathematicians, physicians and physiologists are necessary stakeholders that bioengineers should consider and work alongside in order to create ideal wearable devices. (Carlson, 2009). This development should occur before any major technological entities become fully integrated into society, otherwise their complications will become difficult to control. The tightly coupled Technical project and STS Research will shed light on the subtle ways of how personal beliefs about the world and technology can hinder personal growth, and provide solutions to these problems in order to empower humans interpersonally and intrapersonally.

OVERVIEW ON RAPID INTEGRATION OF WEARABLES IN SOCIETY

Data gathered by Statistica, a German online portal for statistics used by business customers, lecturers and researchers, noted that wearables are becoming increasingly trendy in the consumer marketplace with sales jumping from 526 million devices connected to the Internet to over 1.1 billion expected in the year 2022 (Liu, 2019, p. 1). Not only is the quantity of wearables rising, but also the vast amount of applications and services they provide is increasing. These electronics have extended their reach from the basic functionality of providing telecommunications to becoming vital benefactors of health and fitness due to their ingenuity in monitoring bodily function. In health services, consumer wearables have the potential to provide patients with personalized health data, which is intended to assist with self-diagnosis and behavior change interventions. However, concerns of safety, reliability, and security of consumer wearables in health care needs to be addressed. In 2016, Piwek et al., a group of Data Science researchers affliated with the University of Bath who wrote for PLOS Medicine Journal, warned that "less than 5% of surveyed health care providers felt that any Internet self-diagnosis was helpful (para. 12)." Therefore, integrating diagnostic procedures into wearable devices may prove to be unreliable in the current state of affairs. Presently, the newfound services of consumer wearables are impressive in that they are extended to many facets of society, but the newer and more critical applications that revolve around health monitoring are still going through their trial period.

Extensive testing and verification of data between the engineers and health experts should be emphasized more than the production and distribution of devices in the market and mainstream media. The concerns about safety and reliability of using wearable technologies as

means of health care replacement can be observed below using the System in Context STS framework in Figure 1 on below.

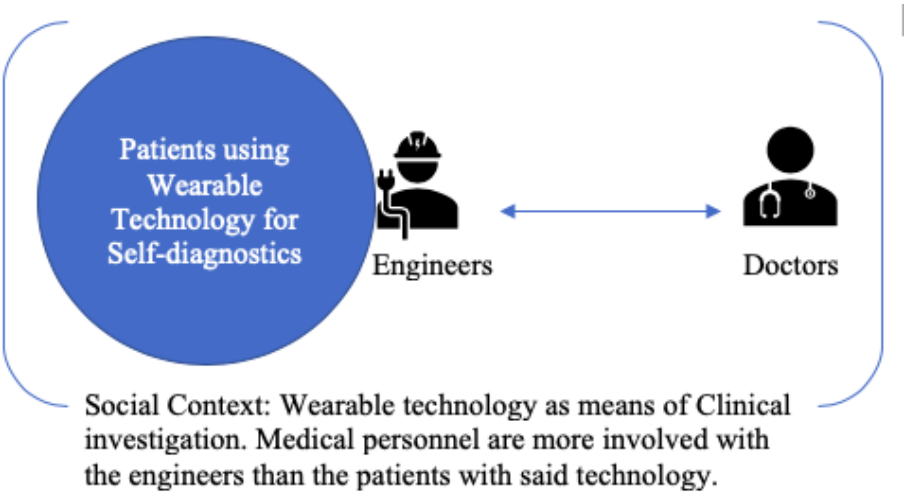

Figure 1: System in Context of Wearable Self-Diagnosis. There are disconnects between patients, doctors, and engineers on their perception of the reliabilities of wearable technology in health diagnostics displayed through the System in Context STS frameworks. The boundary is set by the wearable technologies that were created by engineers who gets insight from doctors on what data to record (Adapted by W. Zheng (2020) from W. Carlson 2009).

The human biological systems and neural systems are complex structures that were partly understood through centuries of research done by scientists, and new breakthroughs are continuing to be introduced today. In 2020, it would be unreasonable to think that consumer wearable devices would match the expensive medical equipment used to monitor patients in hospitals. Each human body has its own rich medical history with different reactions when being exposed to various environmental stimuli; thus, identifying abnormalities and tracking the overall rhythm of bodily systems proves to be doubtful with the current components of easily accessible wearables from the market. Uncertainties like these lead to unintended consequences of wearable sensor such as invalidation of security and physiologic errors in the treatment process (Schukat et al., 2016, n.p.). More testing between end-users, manufacturers, regulators, and doctors need to be conducted in order for wearable sensors to be promising for ambulatory

use. Not only would the verification of data be questionable, the security of data may be compromised. Large amounts of data and information on the users are circulating the Internet every day and the pool of data will continue to grow as more and more users purchase wearable devices. Research published by the School of Computing at Clemson University suggests that this may become a bigger problem when wearables increase their efficiency with sensing and storing intimate information about users continuously and discreetly (Motti & Caine, 2015, p.2).

OVERSHADOWING OF IMMEDIATE POSITIVE IMPACTS OVER LONG-TERM NEGATIVES OF WEARABLES

A large fraction of the users do not have a clear understanding of how wearables can infringe upon their privacy, but they reported that they are willing to sacrifice their privacy in exchange of benefits brought by their wearables (Motti & Caine, 2015, p.2). Privacy concerns will include, but are not limited to, location disclosure, lack of access control, privacy of other people around wearers, and speech disclosure (Motti & Caine, 2015, p.4). Aside from negligence issues with user privacy, consumer wearables also have a negative influence on decision-making for its users. For example, research conducted by CNN reveals that Fitbits have helped users achieve fitness goals and feelings of self-satisfaction, but they also experience a dependency on the device in order to complete their activities and allow the device to make most of their daily decisions for them (Duus & Mike, 2016, p. 8). The pressures for the users to reach daily targets and feelings of guilt associated with failing to accomplish these tasks pushes the idea that wearable technologies have influence over human decision-making and allow them to take over human autonomy.

Notably, many users of wearable technology allow their devices to govern their daily lives in order to meet fitness goals as indicated by their built-in monitors. Publications to the ACM Digital Library, a research database with bibliographic literatures and articles covering computing and information technology, from the Copenhagen Business School indicates that information overload on self-quantified data will lead to subservience to wearable technologies and will act in order to hit certain numbers as defined by their technologies rather than taking the time to analyze the data and numbers tracked by the device (Sjöklint, 2014, p. 137). Wearable users can become obsessed with checking on themselves, similar to that of engrossed smartphone users who check their social media posts. According to a Business Insider newsletter, the average smartphone user checks their device "an average of 150 times a day" (Spicer, 2015, n.p.). Likewise, the amount of compulsive checking will likely intensify once a user has information about their own bodily functions (Sjöklint, 2014, p. 138). These occurrences can be considered as an early sign of technological takeover in human decision making. Since it is commonly accepted that modern wearable technology exists to benefit users by providing information about themselves to improve and meet personal goals, discussions about their risks are largely unrecognized.

IMPLICATIONS OF RESEARCH ON DESIGN OF FUTURE WEARABLES

How can we design wearable technologies so that the negative harmful effects are minimized as much as possible? This problem has been the main objective for not only the designers of wearables, but also many different branches of engineers, and. This research examine the current status of consumer wearable technologies and explain their unintended consequences on the human mind, which would increase our understanding of the underlying

problem and result in better design decisions for the creation of new and better wearables in the future. There are relevant studies highlights the unintended repercussions of wearable devices such as a doctoral study done by the Department of IT Management at Copenhagen Business School on Jawbone UP and Fitbit users. Their findings discuss wearables having a significant effect on decision-making through daily challenges created by self-quantification and information overload (Sjöklint, 2014, p. 137). The discussion of privacy is relevant because infringement of privacy relating to wearable technology sensitive data collection has been an ongoing concern since the start of technology's access to interconnected networks. Addressing these issues will aid the design process in making of an ideal and ethically better technology.

As engineers, it is within the profession to enact upon their duty and utilitarian ethics to deliver a product that will attempt to meet these requirements and provide reliable service to as many users as possible. Every engineered product that follows this principle will be able to satisfy their consumers, provide better branding for the company they are servicing, and change society for the better. After all, the purpose of wearable technologies is "aimed at enhancing the quality of life for humans" (Park & Jayaraman, 2003, n.p.).

LIMITED DATA VALIDATION ASSOCIATED WITH HEALTH MONITORS

At this stage of development, the Physiology Research Program division that reviewed consumer wearables from the School of Biomedical Sciences at Queensland University concluded that wearable technologies are not very reliable with evaluating physical and psychological health, training emotional awareness and accessing cognitive function (Peake, Keer, & John, 2018, para. 1). Most of the data recorded by wearables are basic and unconnected, and they are easily distributed to the Internet for companies to target. However, what sets

wearables apart from other forms of social media is that instead of using the device to access the Internet for messaging, emails, and social networks, it causes users to be concerned only with self. Users will self-reflexively check steps, calorie intake, heart rate, or unobjective moods and become more obsessed with their personal "dashboards" despite not necessarily gaining meaningful insights about themselves (Peake, et al., 2018, para. 9). Rather than gaining self-knowledge, there are risks that will make users more self-delusional. Although it is still too early to tell, signs of technological takeover and the possibility of wearables making people more isolated remain to be looming (Duus, & Cooray, 2016, p. 5). To potentially solve the disconnect between information overload and achieving significance on data, implementation of artificial intelligence to provide a "smarter" interpretation of data and a more personalized feedback for users can help increase reliability and eliminates the need to have data stored and distributed to various companies (Peake, et al., 2018, para. 1).

The main propagators of wearable technology are bioengineers. Development of a new and smarter system for validating data collected by wearables should require the collaboration of many more disciplines such as mathematicians and physiologists. The future social construction of wearable technologies is idealized in Figure 2 on the next page.

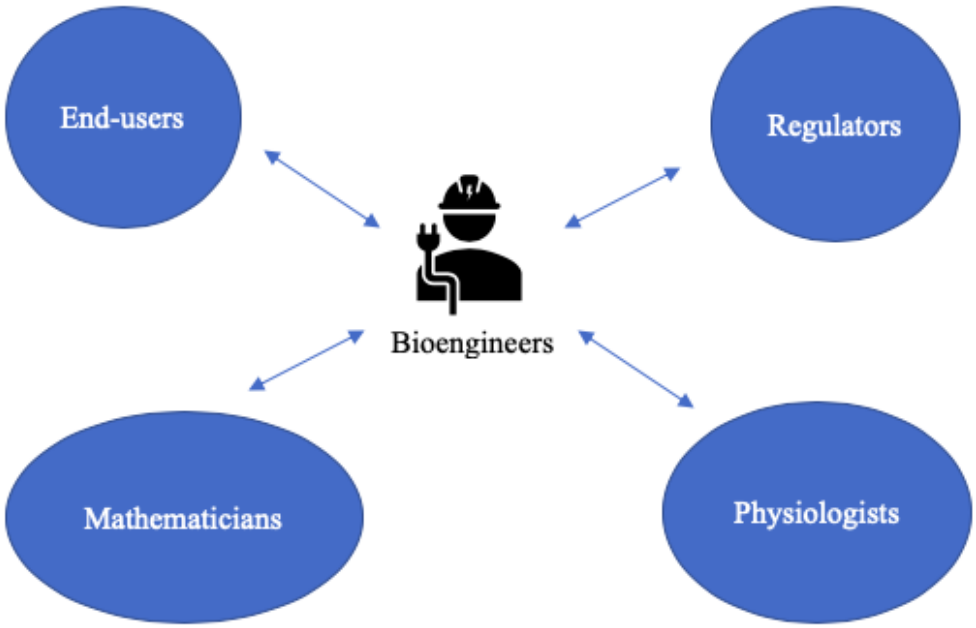

Figure 2: Effective Collaboration with Interdisciplinary Fields: Bioengineers will be able to construct more effective products for end-users once they receive input on better techniques and measurement methods associated with their respective groups. Regulators will continue to be in place to prevent the abuse of data collection on the end-users (Adapted by W. Zheng (2020) from W. Carlson 2009).

Under the guidance of the various disciplines and stakeholders shown in Figure 2, the products designed by bioengineers shall be less error-prone with techniques of error analysis from mathematicians, more medically data-rich with the expertise of physiologists and provide better and safer user experiences with feedback from end-users and regulators. In this scenario, the Social Construction of Technology model (Carlson, 2009) provides a framework for a possible solution to the recurring issues of wearables. The development will not be as difficult as inventing something new because the heart of wearable technologies is aimed at enhancing the quality of life for humans anyway.

Therefore, tweaks and enhancements made to existing systems and models of wearable technologies should be the only add-ons that are required. Another big issue with wearable technologies is their limited energy efficiency, as they can cause users to be more concerned

about maintaining its power rather than having control over it and using it for their own sake. Increasing its efficiency may serve to decrease their distraction capabilities that are in-line with technological takeover, and one way to do so can be through the implementation of solar cells to charge these devices (Peake, et al., 2018, para. 6). Once energy advancements become more polished and commonplace, new ways of charging should be introduced into the fray. Another more interesting thought experiment would be to make these health monitors be sentient, meaning that technologies can evolve autonomously and accommodate for people's evolving physiologies and interests, because the uniqueness of each human body embodies a structure that is difficult to standardize (Peake, et al., 2018, para. 1). If wearables could learn new things about individual preferences and evolve to provide more personalized recommendations for humans, they could achieve even greater health improvements.

Wearables should also seek to become more permission-based as to provide users with greater control over how much the trackers can gather information about the user. Limiting the amount of data collection for wearable devices may introduce more errors and uncertainties in terms of calculating derivative bodily measurements, however this should be made apparent to the users as a disclaimer (Piwek et al., 2016, para. 16). Likewise, using only one wearable device such as a smart watch or FitBit to monitor the physiology of the human body are limited to a single point on the wrist. If devices were instead made with multipoint designs, then much more of the human body can be pinpointed and accurately accessed. This will provide a holistic view of how their body is moving and performing across multiple devices and sensors, generating more accurate and intuitive data (Peake, et al., 2018, para. 8). All of these ideas and potential solutions can be made possible through the Social Construction of Technology with multiple

different academic disciplines and be subsequently verified and validated by mathematicians and end-users.

THE FUTURE OF WEARABLES

The future of wearable technology shows promising potential because there are many creative ways to approach solving the predefined problems of wearable technology. Not only is wearable technology full of potential, their conceptions are also extremely malleable by the human imagination in that no single piece of wearable technology hardware will become the face of such devices. With huge incorporations into multiple systems such as commercial uses, navigation, advanced textiles, and healthcare, there needs to be long-term continuous testing before wearables can administer any of these systems in full swing. The testing and experimental phase will continue to be a long and rigorous process, and the advertisement and touting of the health monitoring prowess should be kept at a lower bar.

Like many newly introduced technologies, such as automobiles and the global positioning system, their evolution needed to take place before virtually every consumer in the world began using the technologies. Since wearables are hardware with multi-disciplinary functionalities, incorporating each branch of science and mathematics will require continuous integration and updates to the pre-existing models of wearables. Many technologies follow the same course of action where technologies are upgraded every year and new models continue to surpass their previous builds. However, consumers must understand that smartphones and smartwatches today are constantly evolving, and users are still considered beta-testers. Automobiles and global positioning systems have largely become standardized no matter which companies are providing the products. Their functionalities remain to be equivalent across all up-

to-date models, with minor differences in fuel usage types of automobiles and graphical display of global positioning systems.

As of now, it is imperative to understand the potential unintended consequences of these trial devices before they have too much control over our lives as well. Never before has computing been small enough to be worn relatively with ease around the body, presenting opportunities for breakthroughs in medical advancements as well as dangerous misinformation and isolationist tendencies. This unpredictable state of wearables will continue to persist into the distant future. Until then, the most effective way to ensure that wearables can become a valuable asset for wellness is to continue periodic testing and implementing creative solutions using the STS framework for the Social Construction of Technology for wearable devices with multiple stakeholders and academic disciplines. Once wearables have explored more possible solutions and tweaks ranging from artificial intelligence implementations and multipoint sensors, they can become truly reliable. This research on wearable technologies along with the technical project serves to propagate a culture of personal and organizational fulfillment throughout society. Drawing awareness to our own interpersonal biases and of how current wearables may be harmful to our well-being will curtail the setbacks that will keep society from evolving into a healthy, global community.

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