Wearable Technology in Healthcare

BA Product Design Stage 3 | Context and Rational Paper Unit 9

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Contents

Hypothesis

MPO (Medical Product Outsourcing) estimates that the consumer wearables market is expected to reach $4 billion us in 2017. However, many wearables are criticized by medical professionals for being a solution in search of a problem when targeted at the personal health industry.

How can design make consumer wearables more viable in the personal healthcare industry?

Market value of wearables

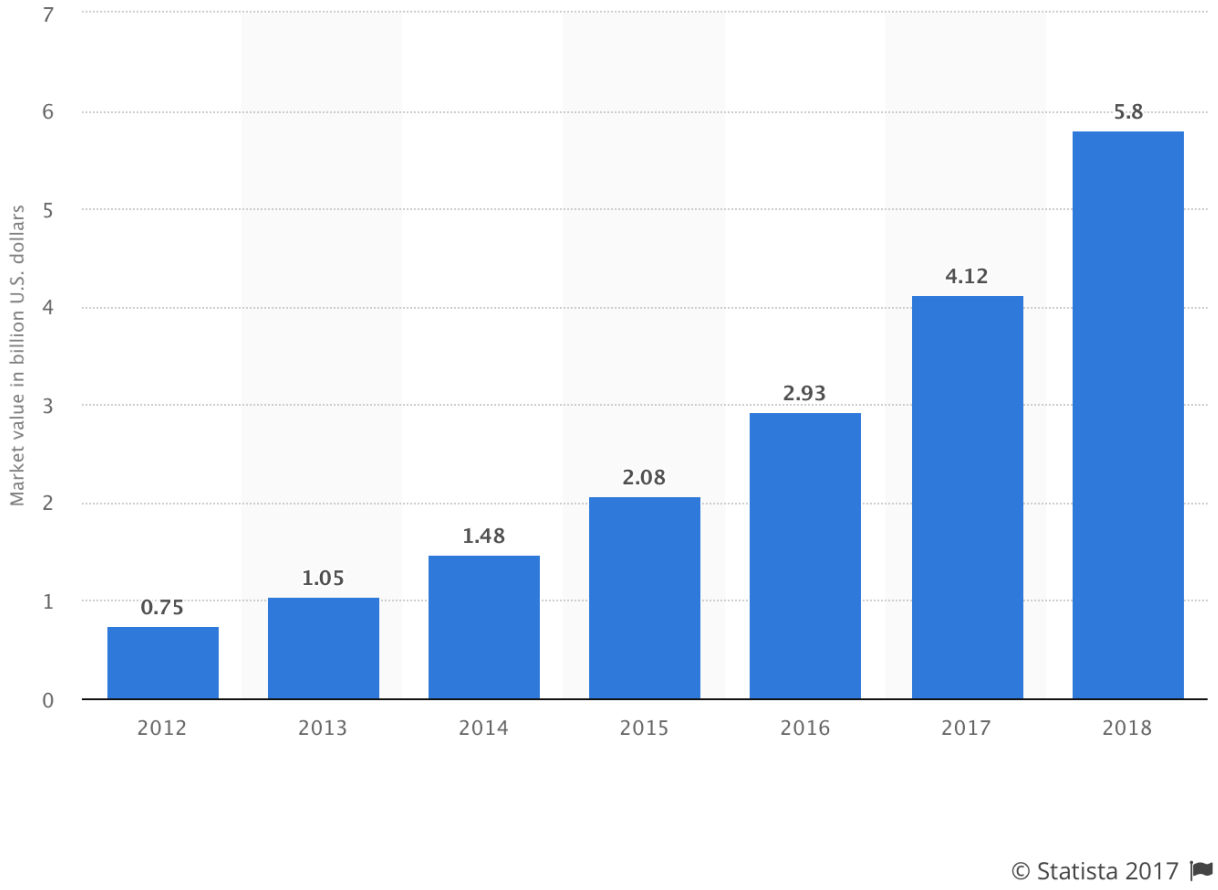

Figure 1, graph of annual market value for wearables, 2017.

Above is a graph showing an increase of market value for wearables and a projected value for the future. We can see from this that the market is expected to reach $4 billion in 2017, and almost $6 billion in 2018.

A crucial moment

When Arne H. W. Larrson became the world's first recipient of a cardiac pacemaker in 1958, it revolutionized the healthcare industry. (Altman, 1973) Since then, it opened inconceivable doors to what the healthcare industry can be. "While the technical concept of the pacemaker has remained unchanged for the past 60 years, the recent introduction of the leadless pacemaker is a revolutionary development that will improve patient comfort" (Pelletier, 2016) Arguably one of the first medical wearables, the pacemaker has seen constant development from immobile A.C powered clunky devices to battery-powered lightweight invisible devices. This constant application of technology to benefit the healthcare industry is paramount to the ever-increasing health issues that arise on an annual basis. The latest trend in the market, and it has been on a constant rise over the past few years, is wearable technology. "The wearables market is expected to reach over $4 billion in 2017" (Bolduc, 2017) The main body of this text will cover issues regarding wearable healthcare including: why is there a separation between consumer and medical wearables, how design intervention could solve the issues, whether or not society is ready for this technological advancement and what lies in the foreseeable future. It will discuss these areas by drawing conclusions from reviews of publications and studies relating to wearable healthcare. This will also be followed up by a review of design precedents relevant to the subject area.

Before we can even begin to discuss this subject area, a line must be drawn between the terms consumer wearables and medical wearables to define them better. Mike Bolduc is a global marketing manager in the healthcare sector and has studied the market for wearable healthcare. His statements on consumer wearables and medical wearables are “While the premise is the same-the products need to be comfortable, easy to use, and not cumbersome-their functions serve a different purpose” (Bolduc, 2017) Difference being is that consumer wearables are tasked with functions like fitness tracking and diet tracking while medical wearables have a bigger emphasis on detecting life-threatening conditions, collecting biometric data and drug administration. In short, “consumer wearables can be considered a superfluous indulgence while medical wearables are more mission-critical.” (Bolduc, 2017)

Why is there a divide?

“A key reason why wearable medical device adoption is not yet mainstream, is the stringent safety and accuracy standards they must meet.” (Bolduc, 2017) This is a big area if consumer wearables are to ascend to a medical level as current products on the market have a clear difference in technical capabilities. Looking at popular wearables on the market like Fitbit (See design precedents 2. Fitbit.), even though their functions on tracking things like your heartrates and footsteps are up to customer satisfaction, it still has massive data discrepancies when compared to actual medical devices. In fact, studies have shown that there is an error margin of up to 25% when compared to different devices on the market. (NCBI, 2017) On top of this, many wearables are being marketed as a device that can improve your general health and fitness. This combination of incompetent technology and false advertising is a big obstacle for reliability and needs to be solved before consumer wearables can “be considered for any medical application.” (NCBI, 2017)

“Why is healthcare design so terrible?” (Dawton, 2017) is a question raised by Jim Dawton who has had many years of experience in the field of medical design. He breaks down this question into two areas of design needs and healthcare needs. The needs of design are desirability, usability, and expertise. Healthcare needs, on the other, hand are feasibility and vitality. Though concise, it does outline a colossal issue that is; design in healthcare only focuses primarily on function and nothing more. “Additionally, recent survey shows that 32% of users stop wearing these devices after six months, and 50% after one year” (NCBI, 2017). “Another barrier to entry could be fashion, as 62 percent said they wish wearables came in forms besides wrist bands and

watches, 53 percent wanted wearable devices that look more like jewelry.” (Nielsen, 2014) These two studies by the NCBI and Nielsen further supports Dawton’s statement as, due to the lack of focus on design for desirability, usability, and expertise. The wearables are just not appealing to the users on a personal level.

Perhaps another reason for this divide is because medical professionals are simply just not endorsing wearable technology. After all, consumer wearables are scrutinized by healthcare professionals for being “a solution in search of a problem” (NCBI, 2017) Narrowing down the pool, Cello Health Insights did a study on usage of technology by healthcare professionals. Their study Digital Health Debate was conducted through 630 different Doctors ranging from general practitioners to rheumatologists.

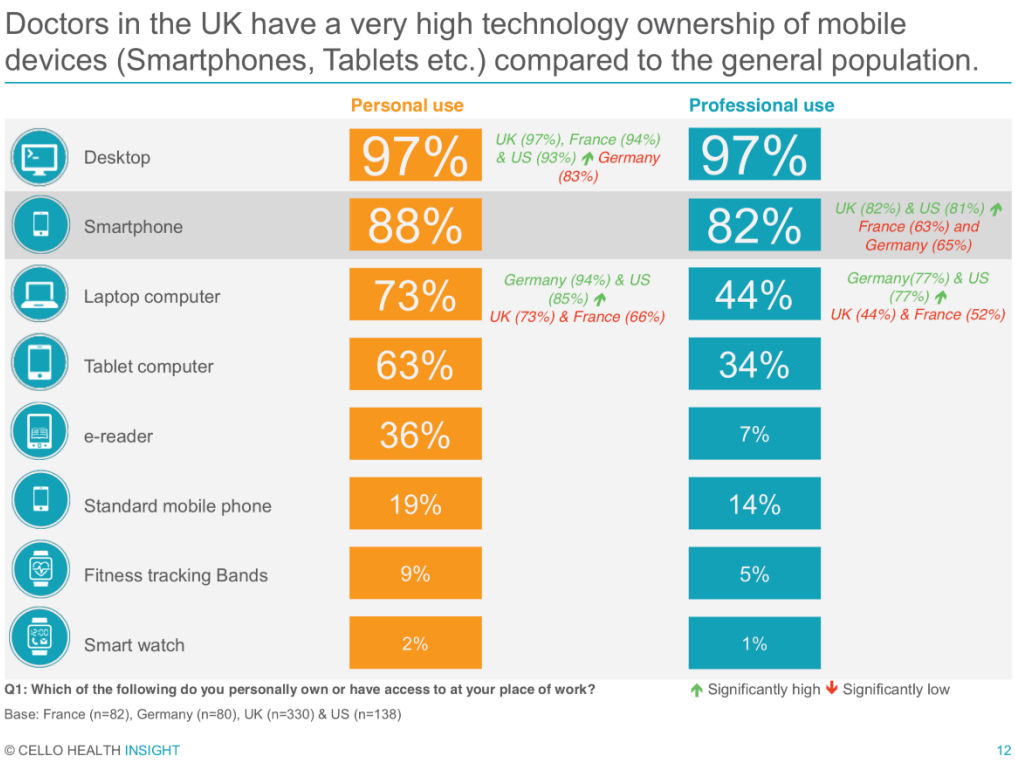

Figure 2, statistics of adopted technology by Doctors, 2014.

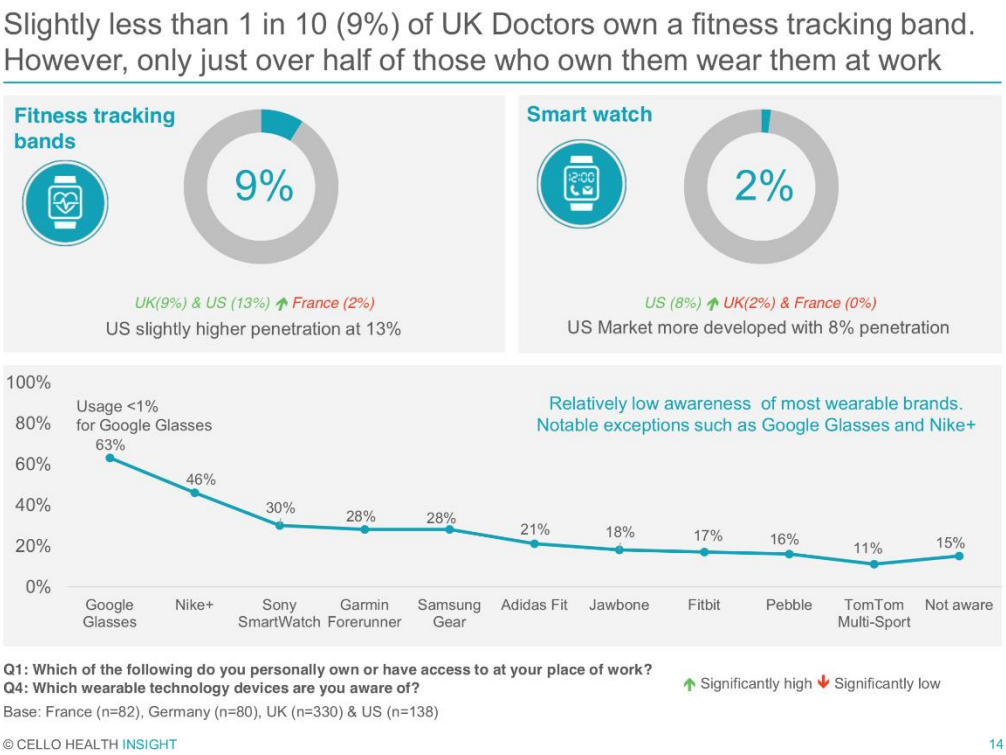

Figure 3, statistics of adopted technology by doctors, 2014.

From the studies, there’s a shockingly low amount of healthcare professionals who wear consumer wearables. Only 9% of Doctors in the UK use fitness tracking bands, and an even lower 2% wear smartwatches. Furthermore, only 44% of these Doctors actually wear them at work (Cello Health Insight, 2014, page 6) This is another major obstacle to climb if consumer wearables are to bridge over to medical wearables. Having healthcare professionals, acting as ambassadors of the products if you will, use these wearables will be a great help to both the technical competence of the product and image.

We can conclude from this that the three major obstacles facing the bridging of consumer wearables to medical wearables are: to increase the technical competence of the components, have a larger emphasis on the needs of the user asides from just functioning for specific health issues, and to increase the adoption rate of wearables in the livelihood of healthcare professionals.

Design intervention

Technological revolutions are becoming a creature of habit as “we have a much better understanding of the relevant technologies and how we can interact with them than we did only a few years ago.” (Marzano, page 9) An example of this is the rise in ambient intelligence in recent years. What is ambient intelligence? Simply put, it’s a scenario where technology becomes invisible to the user, but is powerful enough to cater to their needs. (Collier, Thelen, 2003, page 78)[1] In their book *The New Everyday: Views on Ambient Intelligence*, Emile Aarts & Stefano Marzano explore issues regarding if technology will benefit us or will it become a drawback. Both sides of the arguments are scrutinized with great detail, as they understand that “technology itself is neither good nor bad; it is how we use It that makes the difference. (Marzano, 2003, page 8) One big change that enables ambient intelligence is the downsizing in electrical and computing components over the years as conveyed in this graph.

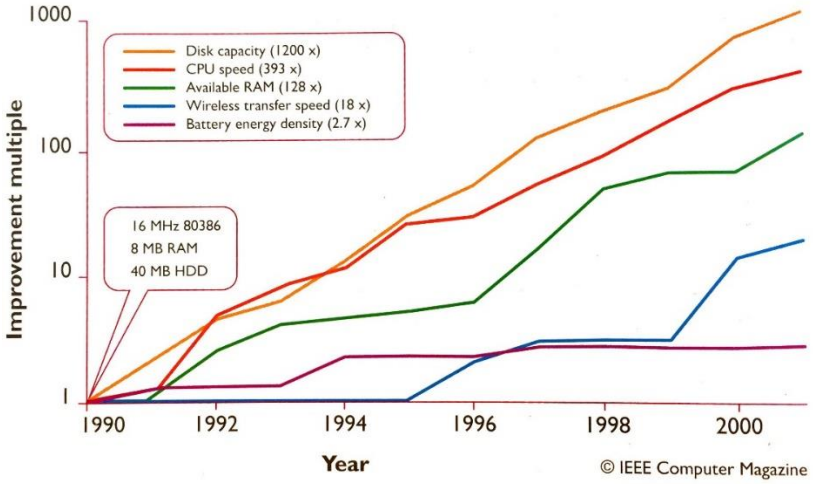

Figure 4, graph indicating the increase of efficiency in electrical components, 2017.

[1] Aarts, E. and Marzano, S. (2003). *The New Everyday: Views on Ambient Intelligence*. Rotterdam, Netherlands: 010 Publishers.

From this, we can see how much technology has improved over the years. The efficiency of components today has increased to what would have been inconceivable levels back in the 1990's. Furthermore, the decrease in size for many of these components is of great benefit to wearables as packing more efficient components into a smaller frame is now a possibility.

Embedded	Many networked devices are integrated into the environment
Context-aware	These devices can recognize you and your situational context
Personalized	They can be tailored towards your needs
Adaptive	They can change in response to you
Anticipatory	They can anticipate your desires without conscious mediation

Figure 5, a table listing attributes for ambient intelligence, 2003.

A table is provided as well in the book, describing what attributes are required to make a product ambiently intelligent. To summarize, they believe that ambient intelligence is a product that is constantly working in the background of the user, like how modern car keys work. (See design precedent 4. Car keys.) It will recognize the needs of the user and act on behalf of the user to support them. (Gough, 2003, page 162)[1] Furthermore, because all the devices are on a network, they can constantly send and receive data allowing the device to adapt on the user's behalf, thereby, enabling the device to function seamlessly in the background.

[1] Aarts, E. and Marzano, S. (2003). *The New Everyday: Views on Ambient Intelligence*. Rotterdam, Netherlands: 010 Publishers. Page 162

This change in technology, however, cannot happen without any negatives. Marzano mentions that from a practical standpoint, business will have to change their whole model as electronic companies will probably have to collaborate with all industries. (Marzano, page 11) Furthermore, they analyze issues from the consumer's point of view as, using their example of wearable technology, users might question the washing instructions because after all we are taught from a young age not to mix water and electricity. (Heerden, 2003, page 280)[2] What Heerden says is very true and must be considered for wearables. New technology will always require a learning curve for the user, and if this curve is too big, the product will lose its sense of familiarity.

This application of ambient intelligence is key for designing wearables as one of the highlighted complaints by the NCBI was that due to the effort required to interact with the products, there is no longer a seamless user experience. (NCBI, 2017) However, with relevant data combined with the best available technology, consumer wearables could function on a medical level of competency without sacrificing the user-friendliness. This, however, has a very fine line before crossing over to a totally radical product where the user interface is completely alien to the user which will require the user the re-familiarize themselves with the wearable. With this change in technology, it would not be impossible for users to become reliant on such products, which isn't a problem if the product is designed well, and maybe fall victim if the device should malfunction or is unreliable.

[2] Aarts, E. and Marzano, S. (2003). *The New Everyday: Views on Ambient Intelligence*. Rotterdam, Netherlands: 010 Publishers. Page 280

Big data has been a highly debated area, especially for healthcare. This is because of the great potential it can bring to the world with a global network of shared knowledge and data which can streamline healthcare services. Though it is not a real example, the film Elysium (2013) has created an imaginary world with a medical utopia. The film features a medical bed that scans the user and detects all health defects that is present. Just to take it a step further, the bed then proceeds to heal the user completely, restoring them back to a healthy state. The example set by Elysium is obviously very futuristic, but “Given a choice, people will prefer to keep their bones from crumbling, their skin supple their life systems strong and vital” (Greenfield, 2004, page 4) No one wants to wither and die, and with what big data can bring to the table, there is a big reason for humans to pursue this. Bringing big data down to a more grounded approach, wearables that utilize big data can be a platform that can manage long-term conditions in a home environment. (NCIB, 2017) Having this huge pool of data will also enable the possibility to create an internet of things within the healthcare industry as devices can function seamlessly with each other.

Though it all sounds like sunshine and rainbows, the approach to big data on a healthcare level needs to be handled with great caution. As mentioned earlier with the obstacles, there is currently an issue of consumer wearables collecting data with huge discrepancies. There is evidence that successful wearables are usually designed specifically to monitor and treat conditions that “cannot be addressed by a smartphone app”. (Bolduc, 2017) This highlights a very current issue as there are many consumer wearables that operate concurrently with smartphones. Though perfect for tracking

one’s heartrates and footsteps, crossing the threshold into medical data collection will render the current method as incompetent.

Besides facing discrepancies in recorded data, the issue of data privacy will also be questioned. In the case of medical data, it is considered an extremely sensitive material to people and most would like to have this information kept discreetly. “For technology companies this brings a new set of challenges, outside of financial information, health related data is probably the most sensitive we possess as people. The protection and valid use of this information must be paramount in the minds of those that enable information exchange. (Cello Health Insight, 2014, page 31) Data in a consumer wearable is generally tracked through an application on a smartphone, or a private party i.e. the manufacturers. Though manufacturers of consumer wearables will always have a data protection policy, soft copies of data are always prone to corruption and hacking. Medical wearables however have their data compiled directly by healthcare professionals. Having spoken to a Doctor, he confirms this statement on how data is stored in a professional institution. “We have both paper record for everyday purpose and electronic database. The electronic database contains all investigation results like blood, XRAYS, plus summary of each admission and clinic visit.” (Kumamoto, 2017)

There is no question that big data will be incorporated into wearable technology on a fundamental level. The amount of potential it can bring to the table is simply too important to ignore. Design intervention can see to this by utilizing the best-suited components to wearables in order to have a device with the technical competence to function on a medical level. To challenge the issue of data privacy and security, we can build on Marzano's statement regarding a collaboration between businesses and consumers. In this case, perhaps implementing a system where data is collected directly by healthcare institutions will provide a better sense of privacy to the user. This in turn will utilize big data to its full potential in medical wearables.

With these two very big suggestions to how design can improve consumer wearables, a reality check is needed to see how feasible these suggestions are. Looking back at the start of the paper, the three big issues outlined previously were: the severe difference in technical capabilities between consumer wearables and medical wearables, larger percentage of users discontinuing the use of their wearables and the lack of healthcare professionals using wearables resulting in a negative perceive image.

The actual availability of technology that allow consumer wearables to cross over into medical wearables territory already exists. It exists within medical wearables and other healthcare devices. The major barrier to technology here is monetary. Throughout history, new technology has always been more expensive. This is due to the lack of industry when something new comes out; the required level of demand simply is not enough to justify the investment needed to expand the industry. This may have been an issue five or ten years ago for wearables but looking at the figures of the graph in *Figure 1*, it is evident that there is a slight exponential growth in market value. As the demand for consumer wearables increases, it will ultimately drive the costs lower as the industry will have more money pumped into its economy.

Having a technologically apt wearable alone is not enough, as the second issue raised was that a large percentage of the user discontinued the use of their wearables. “Much of the assistive technology equipment prescribed to users ends up languishing, unused, in cupboards.” (Newell, 2006, page 177)[1] As Dawton pointed out, the needs in design and healthcare are currently different and do no crossover.

[1] Clarkson, J., Coleman, R., Keates, S. and Lebbon, C. (2006). *Inclusive design.* Enkskede. TPB. Page 177

In other words, there is presently a lack of ethnographic research in the wearables industry. This is evident because not every aspect of the user's needs is satisfied. Neilsen's study on the users revealed that smartwatch users have a more prominent emphasis on functionality and comfort, while fitness band users focus more on accuracy and battery life. Both target groups also look for durability attributes in their wearables. Furthermore, there is also a majority of users who wish that the typology of wearables could be changed to things more fashionable like jewelry. (Neilsen, 2014) With this in mind, design can expand the typology of wearables to better satisfy users. After all, most wearables on the market are not considered as fashionable at this stage. (Newell, 2006, page 178) [2]

If these two areas of wearable technology can be implemented well, perhaps consumer wearables can cross over to medical wearables. The technical competence is sure to gain the approval of healthcare professionals which will ultimately resolve the issue that there's a lack of wearable adoption within the healthcare industry.

[2] Clarkson, J., Coleman, R., Keates, S. and Lebbon, C. (2006). *Inclusive design.* Enkskede. TPB. Page 178

Are we ready?

In the presence of technological advancements, there will always be a group of people who find it challenging to cope with the change. They will not be able to shield themselves from these constant changes that require society to adapt to. (Robins, 2005, page 1) In the book *Tomorrow's People,* Greenfield digs deeper into analyzing people who cannot accept technological change. She refers to them as The Cynics, or techno-cautious/ technophobe for us, (Greenfield, 2004, page 3), and lists further reasons for why she thinks these people are so afraid of technology. It's a very real scenario as her statement earlier regarding how technology has enabled people to view the entire world has shown them not only the positives, but the negatives of technology as well. Other than people who are technophobic, it's widespread belief that the older generation of people will find it harder to cope with the change in technology. In fact, the cognitive abilities of people tend to peak out at the early 20's and hit a plateau until the 50's and 60's before it begins to decline. Catering to the older generation is usually a strong business incentive as their large demography gives them a massive spending power. (Huppert, 2006, page 31)

We live in a society that is very reliant on technology today. "The very fact that there was television at all transformed not only people's lives but also the way they viewed the world beyond the confines of their own community." (Greenfield, 2004, page 1) Greenfield illustrates, through the example of a television set, that technology has become an integral part of learning for people. Furthermore, she states that because youths are immersed in technology from a young age, we as a society are now more or less competent with technology. Because of this change in habit, our old views of the

older generation being less capable of handling technology are obsolete, and it would be wrong to think so. A study was conducted on the senior population in the United States. In 2013, 18% of seniors been reported using smartphones but that percentage has now risen to a whopping 42%. Around 67% of the seniors today use the internet, and over half of the older demography in the United States have access to broadband at home. (Anderson, 2017)

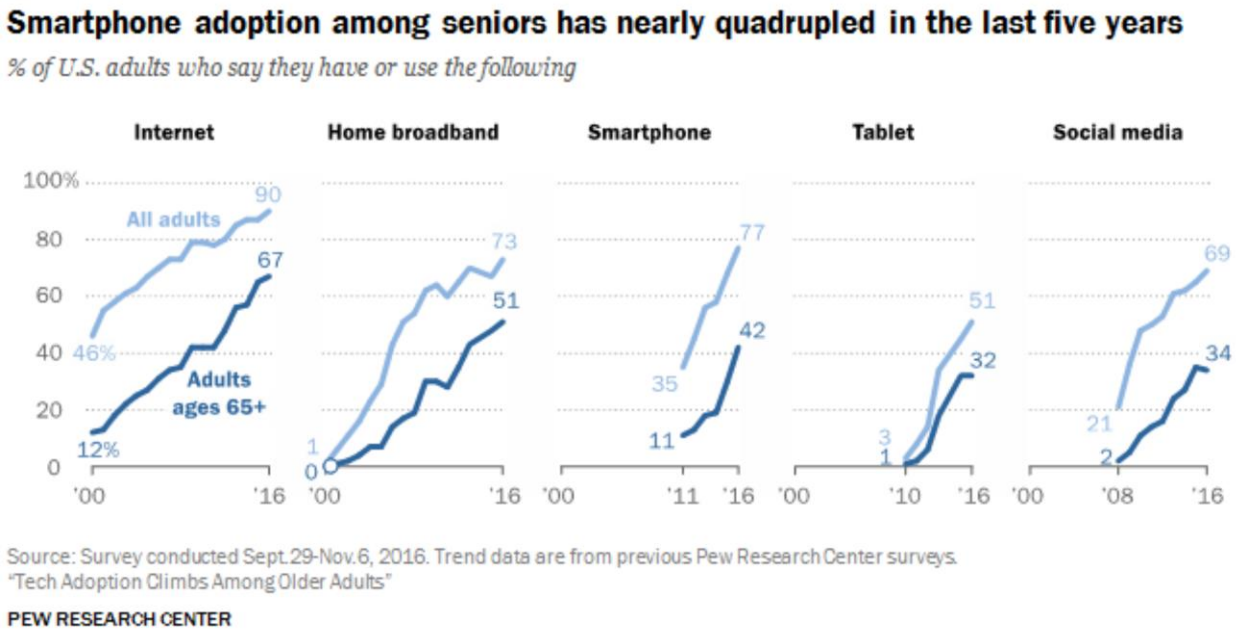

Figure 6, statistics from Pew Research Center for the adoption of technology amongst seniors, 2016

These graphs from the Pew Research Center compare the adoption of technology between all adults and those above the age of 65, and shows an exponential increase over the past decade.

The points raised by Greenfield are all valid, and the possibility that the world will be completely rid of techno-cautious and technophobic are very slim. It's just a fact that we as a society will have to live up to. That being said, this number of people who are incapable of using technology is decreasing by a substantial amount. Furthermore, having technology integrated into the livelihoods and education of people from a young age will result in a society that is perfectly capable of handling the constant technological advancements.

Design Precedents

1. Pacemaker

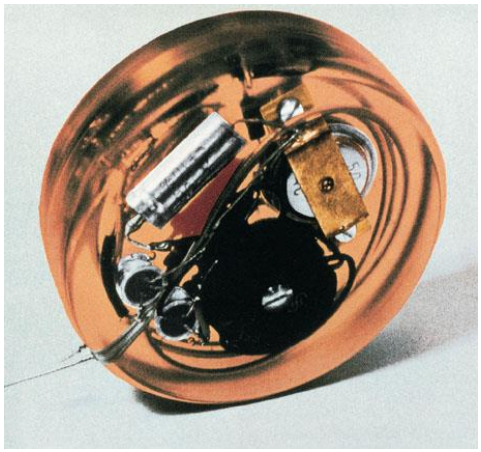

Figure 7, pacemaker, 1958

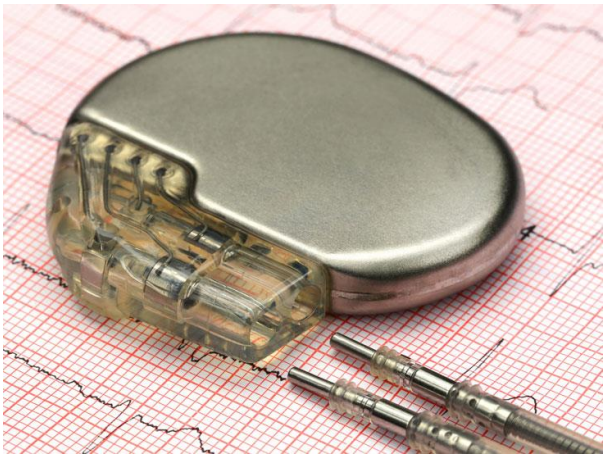

Figure 8, pacemaker, 2017

Arne H. W. Larrson became the world's first recipient of an implanted cardiac pacemaker. Up until 1958, people who had pacemakers were bound to an immobile life as the devices were huge, clunky and not designed to be mobile. With the invention of this new pacemaker, patients could carry out daily tasks with a pacemaker that's invisible to the world. It's tiny casing, and smooth design is aimed to be as unobtrusive as possible to hinder as little activity as possible. Furthermore, the small and neutral aesthetics of the pacemaker remains entirely invisible to the user. This device has seen countless tweaks and upgrades over the years and is now commonly used by any patient suffering from heart conditions. The inception of the pacemaker is arguably the product that started the trend of medical wearables.

2. Fitbit (Smartwatches & fitness bands)

Figure 9, Fitbit, 2017

Figure 10, Fitbit, 2017

Smartwatches and fitness bands are able to track personal data like steps, heart rate, calories of the user. The purpose of which is so to encourage a healthier lifestyle for the user. Small features like reminders to get up and move after the sensors detect still motion after a specific amount of time are excellent implementations. It boasts sleek aluminium frame that is usually paired with a silicone strap giving the watch a lightweight sporty appeal to the user. Though the technology has come a long way, there are still discrepancies in the data as the sensors are not designed to record every form of movement. This ties into the argument regarding the lack of reliable data.

3. Insulin Pump

Figure 11, insulin pump, 2017.

Insulin pumps work by monitoring your blood over 24 hours and supply diabetics with insulin when levels drop too low. You can adjust it for when you eat, or when you're in between meals. This, to many, is a better alternative than to carry multiple insulin injections at all times. The small housing of the insulin pumps allows the user to carry on with daily routines without being impeded. The use of translucent polycarbonate in the casing has a medical typology that gives a sense of technical competence and reliability to the user as they will associate the material with medical equipment. Furthermore, the insulin pump boasts a simple and easy to understand interface to maximise user-friendliness. However, due to the nature of the device being physically implanted to the user's body, not all have welcomed the insulin pump with open arms while others remain using individual syringes.

4. Car keys.

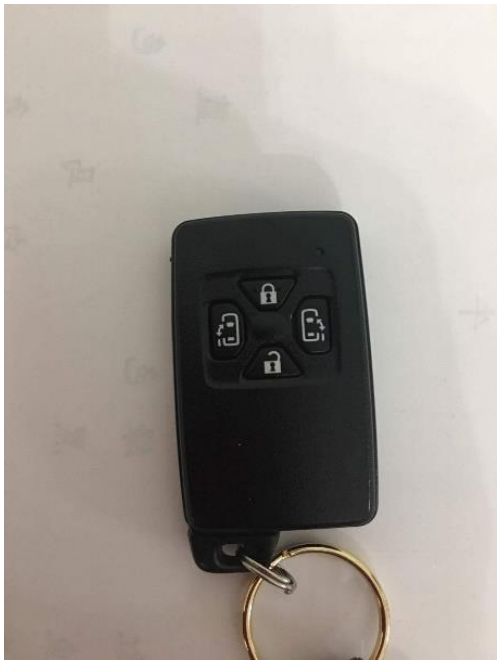

Figure 12, Toyota keys, 2017

Figure 13, Volkswagen keys, 2017

Car keys have evolved from being an analogue key, to infrared transmitters to proximity sensors. The key from the Toyota uses infrared technology so that users are no longer required to lock and unlock their car doors manually. This change in habit is reflected from the lack of an actual key on the fob. Though the function of buttons is still present in modern keys, the ability to automatically lock and unlock your car without having to touch the keys is implemented to most, if not all, car keys. Volkswagen has implemented this technology into their keys. The smooth silhouette of they key encourages the user to leave them in their pockets, purses, and bags, etc. It is an explicit representation of ambient intelligence at work as users no longer have to press buttons to unlock and lock their doors physically.

5. Hearing Aid

Figure 14, hearing aids, 2017

Hearing aids have three components: a microphone, amplifier, and speaker. It amplifies the sound into the ear of a person who is audibly impaired or deaf. This product tries to be as unobtrusive as possible which you can see from the choice of skin tone colours and transparent pieces. This however, hinders the hearing aid to perform at a higher level as there is no space to house better electrical components. Currently, users will have to choose between this universal unobtrusive design or an obtrusive design that performs better.

6. Glucometer

Figure 15, glucometer and reader, 2017

Figure 16, glucometer, 2017

The latest addition to the line of glucometer is the Freestyle Libre System. As opposed to traditional methods of jabbing your fingertips and measuring the sugar level in your blood sample, the FLS has a small wire that is attached continuously to your body. This allows a constant measure of glucose levels on a cellular level which, allows for a more accurate and constant reading. It also saves the trouble of having to constantly buy strips for blood tests. The FLS is one of the first lines of consumer wearables that has crossed into the threshold of being a medical wearable. It is already utilising big data by having healthcare institutions store a total record of glucose levels for the patient's Doctor. However, the utilisation of the reading device can be harder for techno-cautious and technophobic users to comprehend.

The foreseeable future

It is evident that there is still a long way to go for the consumer wearables market, after all, technology is under constant change. The current consumer wearables face the obstacles of technical competence and the lack of ethnographic research, which are preventing it from crossing over into the league of medical wearables. Because of this, the current consumer wearables are not well received by healthcare professionals, therefore resulting in a less than favorable image. These issues however are not impossible challenges that cannot be overcome.

Design can introduce the wearables market to better ethnographic research which will provide a a more in-depth understanding to both the needs of the user and the needs of the healthcare industry, and converge it together. This convergence of demands from both sides is something the industry has yet to see, which is why so many current consumer wearables fail. Implementing the technical capabilities of medical equipment with all the emotive qualities that create a desire for users will see a new era of medical wearables where both industry and user will be more than jubilant to operate. Needless to say, this direction will not be cheap, but like any industry, the increase in market value (See *figure 1*) will allow companies to make more significant investments which will ultimately drive the costs down. With a plethora of technology to utilize, it will be a stepping stone to enable the use of big data to create an internet of things for the healthcare industry. Different medical wearables will be able to send and receive accurate and sound data that can aid both patient and Doctor and streamline medical services to achieve optimal efficiency. Whether it is receiving a diagnosis of sickness, or monitoring long-term chronic illnesses, this network of smart wearables will be able to

assist ambiently allowing the user to have a seamless experience. Furthermore, because healthcare institutions are directly involved with data management, the issue of data privacy will be a non-issue as all sensitive data regarding patients are sent directly to their Doctors. Embedding technology into an early education will raise entire generations of children to be able to comprehend and adapt to high tech devices. Techno-cautious and technophobic people will become a remnant of the past, allowing all of society to embrace every advancement in technology. With the way things are going now, it wouldn't be impossible to foresee a future where concepts like the wearable device from Blade Runner 2049 (2017) that allows blind people to see become a reality. Perhaps even the medical bed from Elysium is no longer a shot in the dark.

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Figure 1.

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Figure 2: Pg. 12

Figure 3: Pg. 14

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Figure 4: Pg. 13

Figure 5: Pg. 14

M. Anderson, A. Perrin. (2017). *Think older people are technophobes? Think again.* (Image) Available at: https://www.weforum.org/agenda/2017/05/think-older-people-are-technophobes-think-again (Accessed 02 Nov 2017)

Figure 6

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Figure 7

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