Antigone Bellanich

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HUMAN-COMPUTER INTERACTION

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Abstract

The importance of human-computer interaction and its relevancy can be observed in our daily interactions with computers. This research paper introduces human-computer interaction in chapter one and its role in the Internet and the web and continues to explore the components of computing devices in chapter two such as the display screen, mouse, keyboard, and newly developed gesture abilities. Chapter three delves into website hosting and servers, followed by data management in chapter four in which companies use the data people generate to gather more data about them. Chapters five and six discuss cyber security and identity theft emphasizing the importance of protecting data at large and on a personal level. Chapter seven is an overview of the open source movement related to human-computer interaction followed by the history of human-computer interaction as it developed from the command line interface to the graphical user interface. The paper concludes with the future of human computer interaction with emphasize in the workplace.

Problem Statement

My scholarly paper will focus on Human Computer Interaction design because everyday we encounter hundreds of objects and devices that we need to use be able to understand in order to effectively complete tasks. These objects we encounter are purposed to perform certain tasks to aide us in what we do. Good design allows for good experiences, however bad design can lead to not only bad experiences but could potentially lead to disastrous and hazardous events if not executed properly. Too

frequently do people blame themselves for common everyday errors, when in fact these errors could have been avoided if there was better design in place.

In the context of this class, I will be discussing the interaction and design of objects that have any type of computing power whether it is the websites we interact with everyday on our laptops, or any such device that accesses the Internet.

My main source of information will come from "The Design of Everyday Things" by Don Norman and "Interaction Design" published by Wiley. I will supplement these two main sources with other articles found in the news or on the web.

Chapter One: Introduction to Human Computer Interaction

Interaction is essential to the human way of life- we interact with other people and different objects thousands of times each day. Interactions are how we learn, how we cultivate emotions and express feelings, and how we connect with people- it's what connects us, our shared interactions.

The focus of this chapter book is human interaction with computing devices. There are many different types of human computer interactions, and the list is constantly expanding because many existing technologies are either being expanded upon, or completely new types of technologies are emerging. Interfaces are the means to which a human can interact with a computer. The following is a list of some of the most well known and most used interfaces, however, not all of these interfaces will be discussed throughout the chapters (3).

1. Command-based	5. Information visualization and dashboards	9. Speech	13. Haptic	17. Augmented Reality
2. WIMP and GUI	6. Web	10. Pen	14. Multimodal	18. Wearable
3. Multimedia	7. Consumer electronics and appliances	11. Touch	15. Shareable	19.Robots and Drones
4. Virtual Reality	8. Mobile	12.Air-based gesture	16. Tangible	20. Brain-computer interaction (BCI)

Don Norman, an expert in cognitive science and usability engineering, created the Seven Fundamental Principals of Design for designers of all types to live by in order to create interactions and experiences that are pleasurable for humans. The seven principals are conceptual models, discoverability, affordances, signifiers, mapping, constraints, and feedback. I will explain these principals in terms of physical, everyday items, because if you can understand the basics applied to physical objects, it will become easier to apply these concepts to the computerized/digital world. Conceptual models are what users have knowledge of and apply this knowledge to what they see in order to use a specific design. Discoverability is how a user is able to "discover" or rather learn how to use a new object that they have never used before or are possibly unfamiliar with. In order to learn how to use this new device, users analyze affordances and look for signifiers. Affordances are what an object affords you to do just by looking at it. For example a desk chair affords a person to sit on it, and it's small enough to be lifted by a person. Its signifiers would be

the wheels on the bottom that inform the user that instead of the chair being lifted it can be rolled. The levers under the chair signify that the chair will most likely be able to be adjusted for height. This adjustment is an affordance. Mappings are the layout of switches, buttons, etc. that correspond to certain functions. The knobs on a stove are mapped out in such a way that a user will know what knob to turn in order to turn on the desired gas burner. Constraints are limitations that a person experiences with an object and feedback is the information that a device provides to the user so that they know the state of completion of their desired actions (2).

Throughout the chapters, I will refer to these terms in reference to good and bad design, so it is good to become familiar with them now. If you design with these things in mind, your system, application, product (etc.) is sure to be a success.

Chapter Two: Components of computing devices

One of the first personal computers to have an interface and some early form of a keyboard was at Xerox Palo Alto Research Center, which was developed in 1973 (5). Having a screen on a computer was such a novelty. The mainframe computers didn't have a small personal screen for users to interact with. Originally, the PC interface was limited to the command line, which I will go into more details in latter chapters. Obviously designers and engineers have come a long way since this primitive form of the personal computer; I am fairly certain that the computer you are reading this chapter book on is much more sophisticated.

As personal computers began to gain traction, a mouse became an essential feature to navigate the graphical user interface (GUI). The GUI was an advancement that made computing more user friendly for those unfamiliar with the command line. The mouse allowed users to point and click certain features on the screen. Originally when designing the mouse, engineers that the interaction would have to be exact- so for every inch you moved the mouse with your hand, the pointer would have to move an inch on the screen as well. However, engineers soon discovered that this level of accuracy was not needed in the design, mouse and pointer interaction had to only be an approximation.

This idea became a rule of thumb for a lot of other design interactions. The newest method of interaction is with touch screens. Computer screens now have the ability to sense touch and respond accordingly, and accurately in the sense that the button you touch on the left side of the screen registers on the left side and not the right side, so essentially the calibrations are accurate. In referencing smart phones, there are a lot of new design features that have emerged that users have come to recognize. Sliders, such as those used to adjust the brightness level on your phone, signify a level of adjustment, usually on a scale of "more" or "less". Navigating to different screens on your phone is accomplished through swiping. Accessing specific apps is achieved through one touch.

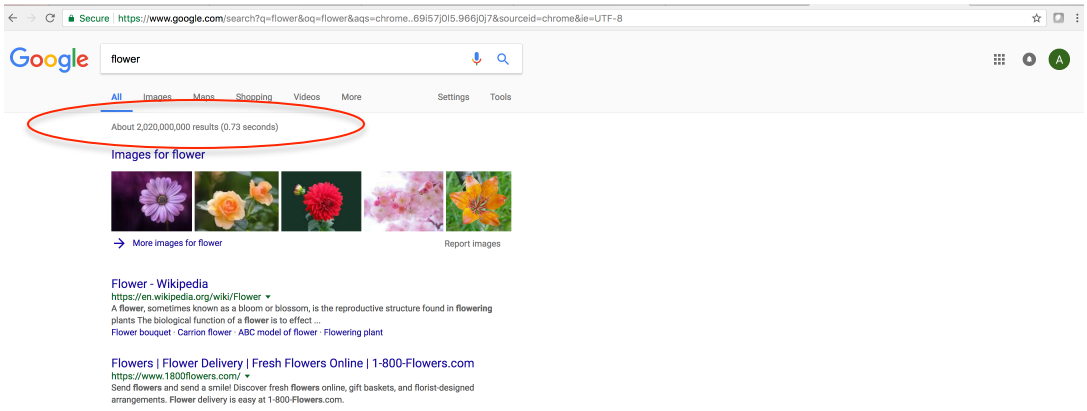
It's quite amazing how far designers and engineers have come from typing words and symbols into a command line to using touch to navigate the same, but more complex computer. The future of interaction is moving away from touch to more air-based gestures. Pretty soon, instead of swiping to navigate through screens, you will be able to just move your eyes to the right to signify to the computer you want to go to the page on the right. Devices such as Google Glass, to just name one of many, have been

experimenting with interactions that don't have to do with touch. Instead tasks are performed and executed through eye movements and voice commands. The abilities of human-computer interaction are rapidly expanding.

Chapter Three: Servers, clients, virtual machines, and other devices

As the field of human-computer interaction is rapidly expanding, the abilities of servers are rapidly increasing, as they are essential to almost all types of technology we interact with everyday. From the websites we use to the applications downloaded on our phones, the information that we see presented to us on the screen is retrieved from a web server that hosts the specific website you are trying to locate and gain access to. A lot of times companies pay for a web hosting company to host their site at a price instead of maintaining the servers themselves. For a company to maintain their own servers, it can be very costly. To access a website, as previously discussed, you need to get the information from a web server, a computer that is always connected to the web, and this web server could be located anywhere in the world. To find location of the necessary server, your computers browser connects to the Domain Name System (DNS) server. When you type a web address into your browser, the computer you are using connects to the Internet through an Internet Service Provider (ISP). This is when the computer then connects to the DNS and provides your computer with an IP address associated with the domain name of the website you requested. The DNS returns the unique number to the computer to create that connection to the web server that hosts the website you want. If everything goes as planned, the web server returns the web page to your web browser and you can now see what you requested (1)! If you think about it, this is an amazing

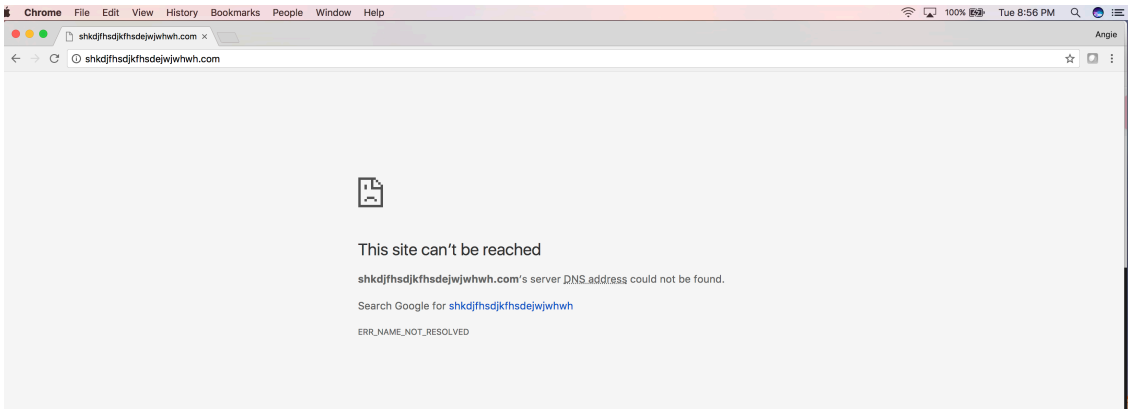
sequence of events that gets processed within seconds- as a user of the Internet your rarely have to wait more than a second for your request to be processed. When I typed into Google "flower" using a Chrome browser, my request was processed in .73 seconds and brought up about 2,020,000,000 related results.



In 0.73 seconds my computer located in Philadelphia, Pennsylvania was able to access information from one of Google's many web servers, some of which are located on the other side of the country in Oregon.

This is the "behind-the-scenes" interaction that humans don't see happening. However, when requests are processed correctly, it becomes apparent almost immediately. The first signifier is that the circular load symbol appears and continuously goes around in circles. Since I use a Mac and run Mac OS, I really dread when I see the colorful rainbow start spinning- I start preparing for some type of problem that I'm going to have to solve. Usually following this rainbow, loading wheel, I see the following message appear on my screen (4). The website I am trying to reach can't be reached. This is another type signifier that web designers have created to help limit my frustration I experience while I try to navigate

where I need to be on the World Wide Web. If you look closely, you can see that the error message says that the website's server DNS address could not be found. Of course this is just a bunch of gibberish letters I typed for the purpose of this example, but this can very well happen if a website address you type is no longer available either because it was taken off the server, or the current server is not properly running for whatever



reason. Google then offers to the user if they want to search the website in their search engine because the another possible reason for failed connection is just that there is a typo in the web address and the Google search engine may be able to pick up on this "slip". This is an example of good design because it's vital for humans and computers to "talk" to each other so each involved party can accurately do what has been asked of them.

Chapter Four: Databases and Data Management

Due to vast advancements in technology in the past decade and even more specifically, the emergence of many different social media platforms, human's have, no doubt, become more connected. Social media platforms have transformed not only our interactions with other human beings, but have transformed our interaction with computers. Everyday thousands upon thousands of people willingly enter personal

information about themselves into some of the world's largest databases. When the need to store information on computers arose, one of the first types of databases was a non-relational database. However, non-relational databases contain a lot of repetition, and repetition causes databases to fill up quickly (because databases are only a specified size-they aren't infinitely large) becoming very large and taking up a lot of space. One solution to this problem was the creation of a relational database in which there are multiple tables of data/information and the tables are linked to each other. Relational databases can become very complex because if there are a lot of tables, database managers need to remember how each table is related to the other tables (6).

Interestingly enough, despite the immense power of the human brain and its many complexities, and cannot compare to the "brain" of a computer when dealing with data. The human brain is believed to store about 2.5 petabytes of binary information, whereas Google processes about 25 petabytes everyday, and is believed to store about 100 petabytes of information, although this information isn't disclosed. To put this into perspective, a petabyte is the size of a million gigabyte drives that you can buy at your local office supplies store (6).

Because there is a growing presence of people using search engines and social applications, companies such as Google have abandoned the relational database tables and have opted for Big Table databases which enable the formation of datasets across hundreds, even thousands, of servers. Other sites like Facebook still use MySQL, an open source database format that is also used in WordPress websites. However, Facebook may be looking to switch to Apache Cassandra, which is closely connected to Big Table (6).

So what happens with all this stored data, what do people do with it? Is it just for the sake of knowing your Facebook friend likes the Rolling Stones and recently watched the Netflix movie "Interstellar"? Stored data could certainly just be used to know more about your friends, but what if it wasn't your friends that wanted to learn more about your interests, but complete strangers you never even met. Stored data has become marketers' best friend; big data has truly revolutionized the world of marketing in the way companies work to create value for their customers.

With database marketing, marketers can get access to your name, address, phone number, email, purchasing history, and any other legally obtained information. This information can be obtained from finance or insurance companies or through applications for free products, credit applications, contest entry forms, product warranty forms – really any type of form that contains personal information (7). This new style of marketing has created a new experience for consumers. For example, many streaming services, such as Netflix, are now able to suggest movies or TV shows you might like based on previous purchases. Let's say you like the TV show *How I Met Your Mother*, Netflix may suggest a similar show such as *Friends*. It can also suggest content based on other people who watch *How I Met Your Mother* and show you their purchasing habits, without revealing their identity. While this feature is becoming more ubiquitous (thanks to the advancements made with databases), being integrated in online advertising as well, some people are very disturbed by they thought that companies are tracking their every move. Even though these services offer a level of convenience, do you want marketers to know every movie you've watched? Maybe marketers knowing what movie you watched doesn't bother you, but them tracking your credit card purchases that include the

medication you buy, which is very personal, can become overwhelming. That leads us to the issue of privacy and security – how much information do you want people to know about you and to what degree can you control the amount of information people can obtain?

Chapter Five: Identity Theft and Individual Cyber Security

With the invention of the Internet, a whole new onslaught of privacy and security issues have surfaced giving rise to some of the biggest problems modern lawyers are challenged with. Unbeknownst to many people, privacy and security are related, but are in fact two very different things. Security has to do with how secure systems are, meaning that are systems safe from viruses and hackers in which these malicious acts information is trying to be stolen. However privacy has to do more with people who have access to this hopefully secure information, yet a person having control, or maybe not having control, over the levels of information they want others to see.

Referring back to the Netflix example in Chapter 4, some users may like that new content is suggested to them, while other may feel it is an invasion of privacy. Should Netflix be held accountable to inform users of the type of data they are collecting, how it's being stored, and who can access this data? Once disclosing this information, shouldn't Netflix then offer users the option to turn off this content suggestion mode? Or does Netflix feel that if you sign up for this service that you lose your rights to control your privacy because you agreed to the terms of services and agreements?

There are no answers to these questions, but in this digital world, many companies are faced with making decisions about these growing issues. Privacy is a huge

concern, and it is up to policy makers to determine this level or human and computer interaction that is deemed societally appropriate for different situations.

Not only is privacy an issue, but also social media has given rise to new forms of identity theft. MTV's show *Catfish* follows the story of people who have formed intimate relations with people online without having ever met them and try to determine if this person is actual who they say they are or if they are impersonating another person to get what they want. Sometimes the person who still another's identity isn't doing so to be malicious, but do so because they have self confidence issues an don't feel comfortable presenting their true identity in real life or even in an online setting. This used to be very common in MySpace chat rooms and is still extremely common on traditional sites such as Facebook and Instagram, and even more non-traditional (dating) sites such as Match or Tinder. In other situations, many fans of famous people create accounts to honor their favorite stars, however this can become problematic for the said famous person featured in the account. Fan accounts can easily be mistaken for a star's real account even when it's not and as a star, you wouldn't want to be held accountable for the photos, words, and actions made be another person. That's why the importance of verifying the authenticity of an account has become very important. On social media networks such as Instagram, to verify a star's personal, authentic account, Instagram places a check mark next to the account name to let others know that this isn't a fan-based account.

While these forms of identity theft tend to be less malicious, it is never okay to impersonate another person by stealing their photos and information from their personal account and tries to make it as if it's your own. However, there are times, unfortunately, when malicious acts are made intentional. There are instances of sexual predators

pretending to be someone they aren't to lure people into unsafe and harmful situations. There are other instances of people impersonating government officials to gain access to secretive information they should otherwise not know. That's why it is important to have good systems in place to maintain authenticity and true identity. In the real world people have badges or are connected to their unique finger ID, however, maintaining true identity in the cyber world is much more complex. Computers all have unique identifiers with IP addresses, but linking specific people to specific IP addresses can be very difficult. In the cyber world everyone looks the same, we all become 1s and 0s.

Chapter Six: Cyber Security and Cyber Warfare

Recently in the news, Equifax, one of the top consumer credit reporting agencies, reported that hackers retrieved company data that was comprised of sensitive information for 143 million Americans, which included Social Security numbers and driver's license numbers. This was the third major security threat since 2015, and as a result of the 2017 attack, Equifax is suffering greatly and has much to recover from. Additional information such as birthday's, addresses, medical records, and bank accounts were among other types of information stolen. The company manages data for more than 820 million consumers and more than 91 million business worldwide. The company also manages a database that stores employee information from more than 7,100 employers. Part of the reason the attack did so much damage was because Equifax uses a more dated form of security when it should use a multi-layered form of security so if one security measure is breached, the company can be informed and solve the problem by putting an end to the attackers before any real damage is done. Because such a vast amount of data was

breached, Equifax, a company that prides itself on data management, has deeply hurt its customer relations losing the trust of many life-long clients (8).

While there's not much for the clients of Equifax to do to prevent these attacks, it is a lesson to be learned for people to pay attention to securing their data before it is too late. Interestingly enough, many companies in general tell their employees to update their passwords every few months to prevent the hacking of an employee account. However, we has humans have a very difficult time remembering passwords, and if we are required to change them every few months, the password is going to be very simple, something that can be easily discovered, or will be written down on a piece of paper that will be stored in a "secret location". Both methods of new password formation defeat the purpose of creating a password that is robust enough to withstand hackers (9).

With that being said, Human-Computer Interaction demands a new form security. We should begin to move away from username/password-based security and begin experimenting with new forms of security such as biometric security. Some of the newest laptops now have the ability to scan users eyes to identify the person and allow them access to their data stored on their computer. This I see as being the future of security.

Chapter Seven: Linux and Open Source

Linux is a free and open source software operating system. Open source software is software made available to the public to be studied, changed, and distributed to anyone for any purpose. Open Source software is great for community projects because many people can work together contributing their code to create a project. GitHub is

development platform that people can use to post their projects and code and also gain access to other code to make changes for their own purposes.

Many embedded systems run on the Linux kernel. Such devices include smart TVs, smartphones, tablets, medical instruments, GPS, and much more. Due to the relatively low cost and ability to customize the Linux kernel, it has become very popular in everyday devices. The Linux kernel is used in CPUSs, which are used as the processor for the computer, and also serves as an alternative to using a proprietary operating system, making it open source (10).

Interestingly enough, Android is Linux based which is free and open source software making software and application development much more popular for developers. The Android Open Source Project offers information and the source code in order to create custom variants of the Android stack, port devices and accessories to the Android platform. In July 2012, Android's smartphone market share in the US was 52% and was 82% worldwide in 2015 (11).

There are many ongoing projects in Human Computer Interaction that are open source and are available for programmers and designers to contribute to.

Chapter Eight: Command Line Interface

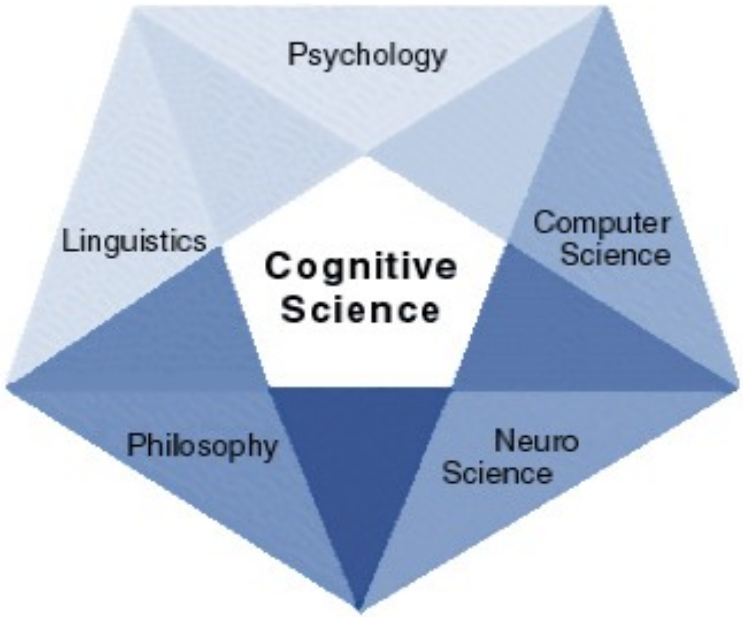
The command line interface, CLI, was among the early forms of interaction between a human and a computer. Even before the CLI, humans used printers, punch cards, and lamps to communicate with people. The CLI was only made possible because of the invention of the Teletype keyboards for input and the cathode ray tubes for output. The command line is comprised of only textual input and output, which means there are

no images displayed. Input comes from the computer keyboard, and the keyboard is used to type command lines that are entered into the shell after hitting the enter key. The shell is a command interpreter that provides the command line interface and then executes the commands inputted by the keyboard. One of the most well known CLIs is MS-DOS (Microsoft Disk Operating System) (12).

The command line is extremely different from the graphical user interface, GUI. People have come to love the GUI and use it more commonly on a daily basis than the CLI. The GUI is comprised of icons, windows, and menus that are manipulated by a mouse. The creation of the GUI allowed for more people to become familiar with computers because it had an easier learning curve than the command line interface. Because it was easier to learn, more people were willing to learn how to use a computer and that helped shift the idea of their only being several mainframe computers in the world, the first era of computing, to the second era of computing, the adoption of the personal computer. However, the CLI is still very important because it can be used when the GUI malfunctions or stops working. On the other hand, some of the advantages of GUIs is that it is more intuitive for many people because it is very visual, it provides immediate to people when they perform actions, and allows for multitasking in which multiple programs are running (12).

CLIs and GUIs can coincide together. While CLIs are displayed by a console, a CLI can also be displayed by a terminal window that can be accessed in the GUI because it has the ability to emulate the console. One of the biggest advantages of a CLI is that it is more powerful and flexible because it has the ability to do things that may be very difficult or even possible to do with a GUI (12).

Despite the advantages and disadvantages between the CLI and GUI, the creation of the GUI launched us into modern approach of human-computer interaction. Human computer interaction didn't begin to emerge as its own field until the mid to late 1970s. At about the same time, the discipline of cognitive science was also emerging as its own discipline as a mix of psychology, language, artificial intelligence, philosophy, and anthropology, which was used to articulate the systems and science needed to develop user interfaces that worked for regular people, those that didn't have a computer science or engineering degree. This is also known as cognitive engineering, in which systems are engineered to coincide with human thought processes, meaning that the systems are made with the user in mind. To me, human computer interaction is the process behind creating systems that promote enjoyable experiences with intuitive interfaces. As I mentioned that the second age of computing was the personal computer, the third age of computing is known as ubiquitous computing and this era of computing is trying to step away from human and computer interaction solely being a person starring at a laptop or computer screen. While human computer interaction and ubiquitous computing are their own separate fields, their interactions with one another are brining us to the cusp of the fourth age of computing, which has yet to be given an official name, but in many ways the future is now (13).



Chapter Nine: Computing Technology and Management Administration

The future is now because many of the cool gadgets we could only dream about or see just in some of our favorite Sci-Fi movies is now a reality. There are currently people in the world who have never known a time without computers, so it's interesting to see how their experiences are similar yet different to those who didn't use a computer until they were middle-aged. To put it into perspective, the smartphone most people carry in their back pocket has more computing power than NASA had in 1969 when they put the men on the moon (14).

Our interactions are rapidly changing. My youngest cousins don't know how to use a keyboard or mouse, so when they touch a computer screen, whether they try to swipe or pinch (some of the newest gestures used for interaction), and they don't get the immediate feedback they expect, they think its broken. It is predicted that in the next five years, the adoption of voice recognition will be over 80% - consider the already existing voice recognition technologies such as Alexa and Siri, which is also an example of artificial intelligence (14).

In addition to voice recognition, virtual reality and augmented reality are gaining in popularity. While it's been mostly limited to video games, imagine a surgeon going into surgery with augmented reality goggles and is provided information about different organs, procedures, and vitals throughout the surgery. The surgeon could possibly see in this augmented reality how to make a specific incision or stich in an emergency situation (14).

Furthermore, perhaps the most rapidly developing technology currently is the wearable, such as smart watches. Some of these devices have multiple capabilities such

as voice recognition and heart rate monitors. As these products develop, they will become less dependent on smartphones and have the ability to do more on their own. However, it is predicted that wearable devices will become obsolete in the next twenty to thirty years because there has already been development with technologies of similar capabilities being directly implemented in the body such as tattoos that can detect sugar levels for diabetics and change colors when they need tend to their diabetes.

As for in the business world and management administration, I think these technologies are going to revolutionize they way we conduct business. From the invention of video calling some years ago that allows for workers to do remote conferencing to the future where we work to create seamless integrations of file sharing where topics covered in meetings are captured and sent to workers to continue development on these topics at their desk. I'm excited to see what the future brings us, and hopefully participate in creating technologies that will continue to improve quality of life brining ease to the interaction between humans and computers as we learn to coexist with one another.

Conclusion

After reading this paper, I hope you feel that you have a better understanding of human-computer interaction and it's importance. Even though it's a relatively new field of study, it has always been a factor in designing systems and has been driven by the human demand for complex technologies that are easy to use. The next time you interact with a website, or use the social media applications on your smartphone, remember

everything you have learned and appreciate the all the efforts of the engineers, programmers, and designers to improve our interaction with computers.

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