

**Developing a Criteria-Based Evaluation Tool for User Experience Design that
Balances Standardization and Creativity**
(Technical Report)

**The Mental and Physical Effects of High Smartphone Usage and the Design
Measures that can be Taken to Mitigate Negative, Unintended Consequences**
(STS Research Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid
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Background

Smartphone applications have gotten increasingly popular over the past 10 years. Mobile app usage is currently at an all-time high and continues to grow rapidly. Application Intelligence Firm, App Annie, reports that time spent on mobile apps around the world hit a an all-time high of over 200 billion hours in April of this year (Kristianto, 2020). This uptick in usage over the past 10 years has created an extremely lucrative and attractive market. Revenue from mobile apps is predicted to hit \$581.9 billion in 2020 (App Annie, 2020). For comparison, Gartner research reports that worldwide revenue for all mobile applications totaled less than \$7 billion in 2010 (Gartner, 2010). Companies are all fighting to make the best apps, and, in such a profitable industry, they are willing to do what it takes to ensure they are at the top. In the early stages of the mobile gaming industry, between 2010 and 2016, consumer behavior involved users playing a certain game for a limited period of time before moving on to the next. Consumers went through games much more rapidly, without much dedication or commitment to one game. This forced companies to adopt a “create and drop” strategy where they developed games as quickly as possible, got them out onto the iOS and Google Play Stores, and then immediately moved on to the next game. Maintenance and upkeep of these apps have typically been very limited, if any existed at all.

However, with higher usage of mobile apps comes higher expectations by users for the look and feel of these apps. The look and feel of a game are determined by that app’s interface design, which in turn directly impacts the user’s experience and satisfaction with that application. While best practices are still being established, many companies have begun to put additional emphasis on user experience through UX and UI. Author Aleah Taboclaon defines UI design as “a series of pages, screens, text entry fields, and visual elements such as icons and buttons that are designed to assist the user to interact with a platform or device. On the other hand, the UX design “involves how easy or difficult it is to navigate or interact with user interface elements on your website. Many UX and UI components can be encompassed nicely by a design system. A design system is a library of visual style elements and components that

creators and developers use to ensure a consistent look throughout their designs of platforms, pages, and systems. By definition, design systems are inherently both technical and social and they can drastically improve the look, feel, and functionality of an app.

Creation of a Design System for Candy Crush Saga

The technical project will focus on the creation and development of a consistent design system for software applications. The Candy Crush Series games will be used as an example to evaluate current components and interactions, identifying contradictory implementations, proposing a standardized design, and developing a method to scale the work up to cover future strategic areas.

Candy Crush Saga is the most popular game in the Candy Crush series with an estimated 273 million monthly users (Statista, 2020). King, the company behind Candy Crush originally predicted players would follow the consumer pattern for other “create and drop” games. However, Candy Crush Saga was released in 2012 and is still widely popular today, 8 years later. With such an extended period of use and high number of users comes higher expectations for the game, and King has been forced to rethink their design strategy. The creators are now tasked with doing something unique for the mobile gaming industry: making large scale updates to meet player expectations and create a better user experience overall.

At the core, this technical project involves the design systems for King’s live mobile games. The current version of Candy Crush Saga, while very successful, lacks a well-organized interface and a corresponding design system. Design systems ensure that the product in question is cohesive and that any changes or updates can be adopted efficiently. King’s lack of a design system means that player’s knowledge of interactions in one game do not carry over to other games, making it more difficult for players to play the entire rotation of King games.

Currently at King, teams are split into “pod groups” consisting of designers, developers, UX leads, and team leads. These pods are each responsible for different functionality's and components within the game. This setup means those team members are able to fully understand the workings of their assigned component, however lack of collaboration between pod teams is a large source of inconsistency throughout the interface. A shared design system will reduce interface design inconsistencies and decrease time needed to make future updates and developments, both of which will facilitate better gameplay and user experience.

Design systems have become increasingly popular and necessary as mobile gaming companies begin to expand and deal with issues of scalability. Design Systems are often created by teams comprised of UI and UX developers and may include engineers, computer scientists, and marketing members. Design systems have proven successful and technological giants like Google, Microsoft, and IBM have publicly accessible design system documentation. Along with increased consistency and standardization, design systems bring numerous additional benefits. Design systems help bridge the gap between teams and limit the amount of additional duplicate work being done, reduce monetary and temporal expenses, limit the frequency of errors, and increase ease of modifications.

Design systems are continuously evolving and have no set framework. The components within the design system are completely customizable. Anindya Sengupta, a UX designer, describes design systems as “the single source of truth for your product’s experience” (Sengupta, 2019). Figure 1 displays possible design system components and a potential organization strategy.

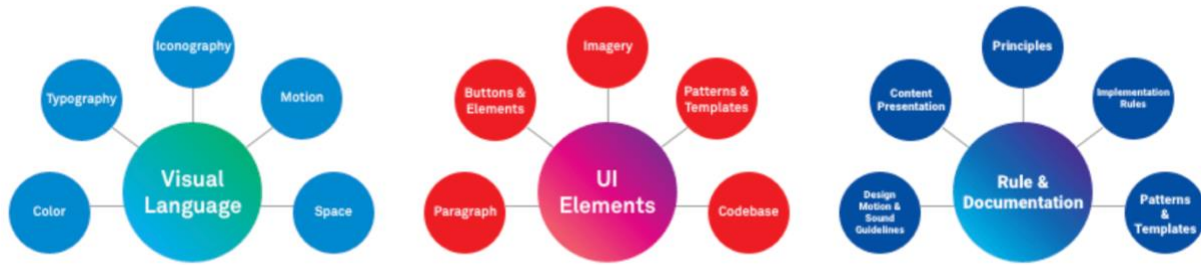


Figure 1. Design System Components (Wipro, 2019)

The creation of a design system is no small undertaking and the creation King’s design system is no exception. The first step is to take inventory of game components, features, and functionalities. Then, multidisciplinary team members will be brought in from King to offer insight into their design process. Through this collaboration and use of our inventory, rules and principles for elements such as typography and color scheme will be established. Next, methods for evaluation will need to be created, which involves developing criterion, parameters, and specifications. Once these are established, testing will be done on use cases. The criteria for these use cases involves a scorecard consisting of parameters chosen by the development team. If the use cases pass, the design system, guidelines, and criterion will be expanded to the rest of the components and the design system will be compiled into a website or documentation resource.

Mental and Physical effects of high smartphone usage

While my capstone focuses on a design system, I want to turn my attention to the effects smartphone use and mobile app use have on the physical and mental wellbeing of users. App Annie (2020) reports that an average user spends 4 hours and 20 minutes per day on their smartphones. With such high smartphone usage being reported, it is more important than ever to examine how this usage may be affecting users. It

is the responsibility of engineers to evaluate the intended and unintended consequences of their ideas, creations, and designs. This obligation is the main idea behind the responsible innovation framework. Jack Stilgoe and colleagues (2013, p.1570) define responsible innovation as “taking care of the future through collective stewardship of science and innovation in the present”

Heather E. Douglas lays out a similar responsible innovation framework to Stilgoe in *The Moral Responsibilities of Scientists (Tensions between Autonomy and Responsibility)*. She explains that scientists are morally responsible for the things they intend to bring about, as well as the side effects of their actions (Douglas, 2003). As a metric for unintended consequences, she offers the categories of negligence and recklessness. Feinberg defines negligence as creating an unreasonable risk to yourself or others and negligence as faultily creating such a risk (Feinberg, 1993). Douglas explains that one can be held responsible for unintended consequences “both when things go the way one expects them to and when things go awry”.

Many games, apps, and websites aim to keep users on their platforms for extended periods of time to increase their revenue and exposure. However, these extended visits are taking their toll on users. Smartphone addiction is becoming more prevalent in the United States as the number of individuals who own smartphones continues to grow. According to a 2016 report from Common Sense Media, 50% of teens feel addicted to their mobile devices, and 59% of parents feel that their child is addicted (Common Sense Media, 2016). Additionally, according to a 2017 survey conducted by Deloitte, 70% of individuals who attempt to limit their smartphone use are unsuccessful (Richter, 2017). This prevalence begs the question of whether these developers and engineers are being reckless or negligent in their designs and creations. As Douglas (2003, p.66) describes, engineers must carefully consider the “possible impacts and potential implications of their work”.

While mobile applications and smartphones are technical elements, this mobile addiction can have extremely large human and social impacts. Mobile addiction can have physical, mental, and academics effects. Beginning with the mental effects, a cross-sectional psychiatric study conducted in 2018 found that “addiction to smartphone usage is a common worldwide problem among adults” and that “the positive correlation between smartphone addiction and depression is alarming” (Alhassan, 2018). Another study of 600 junior high students found a positive correlation between mobile game addiction and social anxiety, depression, and loneliness (Weng et. all, 2019). Additionally, stress, anxiety, and sleep deficit are also associated with internet and smartphone abuse.

In addition to these drastic mental health effects, the negative physical health effects are alarming. Perhaps the most notable physical consequence is a lack of physical movement. As online platforms aim to keep users engaged for as long as possible, users’ physical movements are decreased which leads to an entire subset of physical consequences in itself. A study from the National Center for Biotechnology Information found that “high frequency [cell phone] users were more likely than low frequency users to report forgoing opportunities for physical activity in order to use their cell phones for sedentary behaviors” (Lepp et. all, 2013). In addition, prolonged periods of screen time can lead to strain on the eyes. Nvision Centers reports that “studies have suggested the blue light from screens can damage retinal cells, leading to problems like age-related macular degeneration” (Nvision, 2020). Lastly, as smartphones continue to trend upwards in size, the design of certain apps and mobile interfaces are creating strain on the hands. Figure 2 depicts regions of a smartphone screen that are easily accessible to the hand versus those that are not, based on the position in which a user holds their phone.

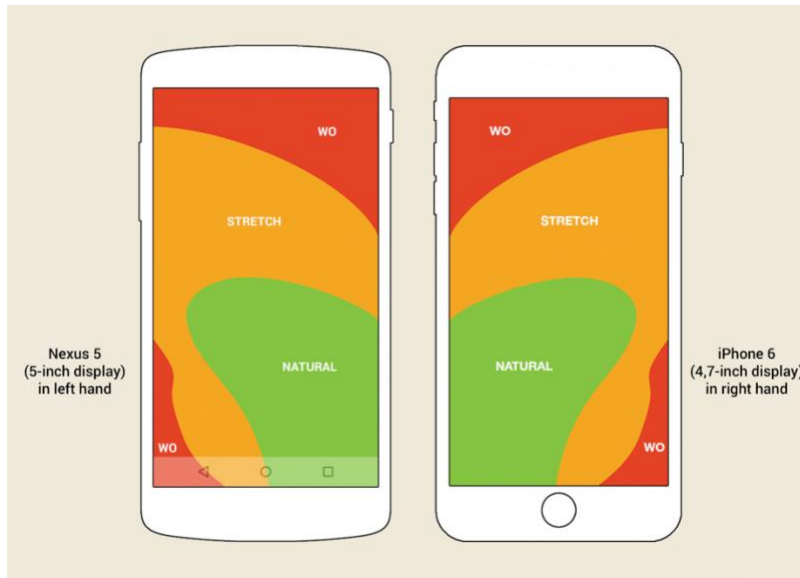


Figure 2. One-handed mobile interface zones (Savchenko, 2015)

The red regions marked in Figure 2 indicate “dead-zone” regions of the screen in which users have to severely stretch their thumbs. Steven Hooper began research on this topic in 2013 and found that the highest proportion of users used a one-handed method which results in the interface zones shown in Figure 2 (Hooper, 2013). Aside from these stretches being inconvenient for users, this repeated thumb stretching can be damaging to the hand. Dr. Wyzykowski of Muir Orthopedic Specialists explains that a common smartphone related injury he sees is injury to the texting thumb, “which is a repetitive stress injury known as stenosing tenosynovitis” (Wyzykowski, 2018). Both the physical and mental health effects tend to be worsened with prolonged usage over an extended time. It is crucial that measures are put in place to help alleviate some of these effects. The two most important strategies to fighting them are to reduce smartphone usage by encouraging breaks and to design interfaces with these concerns in mind.

Some apps have begun to incorporate features that remind users to take breaks, but most apps, websites, and interfaces have no such features in place. For example, Tik Tok, a video-sharing social media app, has incorporated time management videos into users’ feeds that encourage them to take a

break and come back later. When encouraging breaks, it is important to note that even small breaks can be beneficial. According to the American Academy of Ophthalmology, even a 20 second screen break can help reduce eye strain. They recommend practicing the “20-20-20” rule where for every 20 minutes of screen time, a 20 second break is taken (AAO, 2019). Additionally, when designing interfaces and placing high traffic icons and buttons, it is crucial for developers to be cognizant of screen zones. Doing so can help limit strain on the hand and prevent injury.

High smartphone usage research

The research question being evaluated is: *How does high mobile app and smartphone usage affect the physical and mental wellbeing of users, and what design measures can be taken to reduce negative consequences?* More people today have smartphones than ever before. According to the PEW Research Center, 81% of Americans owned smartphones in 2019, a drastic increase from just 35% in 2011 (PRC, 2019). They additionally report that smartphone dependency has been trending upwards over time. With such widespread use, it is critical to evaluate the effects of prolonged use.

To address this research question, I will collect data by distributing surveys and conducting interviews. The main goal of these approaches is to determine how high mobile phone and app usage affects users and what measures may help minimize unintended consequences. Surveys offer advantages such as low researcher bias, precise results, and the high representation. I will use surveys to gather information on frequency of smartphone use, levels of smartphone dependency, and any potential negative consequences. Interviews come with their own advantages and disadvantages. They will allow me to dig deeper into a participant’s thoughts related to these topics with increased flexibility. However, the data will require more in-depth analysis and the sample size will likely be more limited. To analyze the data I collect, I will use both content and procedural analysis. Procedural analysis will allow me to analyze quantitative data I receive from the surveys. Content analysis will allow me to analyze qualitative data obtained from interviews.

My data collection and analysis timeline will be as follows:

February 8 - 12: Create Surveys and Brainstorm Interview Questions

February 15 - 19: Distribute Surveys and Finalize Interview Details. Reach out to professors and see if they may be willing to share my survey with their students.

February 22 - March 5: Conduct Interviews on friends, classmates, and randomly selected participants via Zoom

March 8 - 19: Conduct content analysis on qualitative data obtained from interviews and procedural analysis on data received from surveys.

Conclusion

While it is no doubt that many technologies do more good than harm, it is incredibly important for engineers to take responsibility for any unintended consequences of their work. The world has never been more technologically dependent than it is today, and engineers need to evaluate the effects this dependence may be having on users. The technical aspect of this paper underscores the importance of design systems and details my team's plan to create one. The successful creation of a King design system will allow for a more enjoyable player experience and increase ease of future development. However, other companies are also laying out similar plans to improve user experience in attempt to hook users for longer periods of time. Understanding the effects this high smartphone and app usage has on users can allow engineers to determine solutions to help alleviate some of these unintended negative consequences in the future.

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