

DESIGNING
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UTILIZING
GRAPHIC DESIGN
TO ENHANCE
MEDIA FUNCTIONALTY
FOR THE
VISUALLY IMPAIRED

Designing Clarity

Utilizing Graphic Design to Enhance
Media Functionality for the Visually
Impaired

By: Jeremy Ellison

Master of Fine Arts Thesis Project

*Liberty University
School of Visual & Performing Arts
Department of Studio & Digital Arts*

In Dedication to my students, past,
present, and future. May this remind you
that with Dedication and passion, you
can achieve the impossible

FINAL SIGNATURES

Master of Fine Arts | Department of Studio & Digital Arts
School of Communication & the Arts | Liberty University

Breann Carty, Chair

Chelsea Bass, First Reader

Diane Xu, Second Reader

Todd Smith, Department Chair

Content

As designers, we have an obligation to reach our audience no matter what impairments they may have. As artists, we should desire to bring life and beauty to all. This is our calling.

1.

Research Problem

Graphic design is a staple of everyday life; however, entire groups of people are frequently uninfluenced or even challenged by trying to enjoy visual arts. Visual Impairments not only make it difficult to enjoy graphics, but present a real-world issue in everyday life.



2.

Understanding Color Vision Deficiencies

Visual impairments are a significant issue for designers and consumers alike, but in order to help to compensate for these issues, it is essential to understand them more fully. Here, we will look more closely at what the impairments are and what causes them.

3.

Technologies & Methods

Visual impairments have been an issue within society for some time. In this section, we will look closely at what technologies exist to help with these visual impairments as well as what methods are currently being used to assist those with visual impairments

4.

Correcting the Issue

Upon looking deeply at what causes these impairments and what exists to help with them, we can now look more closely at the best methods of correcting them. In this section, we will be looking at the best real-world solutions for assisting those with visual impairments.

5.

Additional Research

In preparation for finding a viable solution for both consumers and designers to aid those with visual impairments, we first must look more closely at a few more aspects. Here we will look at whom this solution will impact, what possible issues might arise, and how additional research will be approached.

6.

Design Proposal

At this point, we are ready to start thinking about a specific design to assist those with visual impairments. The objective here is to create a physical material that will assist both consumers and designers alike.



8.

Bibliography & Appendix

7.

Design Process

As we continue to work on the physical material being developed for this thesis, documentation needs to be taken to assist anyone in the future who might want to build upon the ideas here. In this section, we will be reviewing the collected documentation.

1.

How do we design for those with Color Vision Deficiencies?

Research Problem

Those with visual impairments are frequently left behind in the design process. As designers, we should make sure that we create more inclusive works and design with the visually impaired in mind.



Abstract

The designed purpose of this research is to help to bridge the gap between graphic design and those who suffer from color-blindness. By not only coming to a better understanding of color deficiencies but also rethinking how we approach our use of color within our designs, we may begin to create more inclusive designs, thus communicating more efficiently.

In a world that is built entirely on visual acuity, there is a large portion of our population that has been left to figure out their own solution to a problem that should be thought of by designers in the first place. These society members have been neglected because most designers and artists are creating a perfect world in mind. Very few designers create products, advertisements, etc... to fit the needs of the visually impaired, particularly those with color blindness. Furthermore, a select number of those with visual impairments wish themselves to be designers, but due to their ailments, they are left to believe that being a designer is a career path that is out of their reach. This issue goes far beyond the scope of just designers as well. This is an issue that has a direct impact on numerous different career choices. In an article on preserving the naturalness of images in the recoloring process, G.R. Kuhn says, "Some professional fields, such as biology, chemistry, geology, fashion design, electronics, and others that require interpreting scientific and information visualization data may be especially challenging for color vision deficient" (Kuhn, 1). Even beyond scientific or creative occupations, visual impairments affect and otherwise limit individuals from their desired professions. For example, pilots are not allowed to have any form of visual impairments, including color vision deficiencies. Sadly, we would rather dismiss an individual with specific, manageable visual impairments, especially when considering that a career passion often

results in a professional rising to the top of their given field. This is not to suggest that individuals with limited or even no sight should be allowed to become a surgeon simply because they want to; however, if there are viable and affordable solutions to allow individuals with color vision deficiencies to work in said field unimpeded by their disability, it would be a shame to neglect them simply because of said impairment.

These two issues are genuine, and although it is not an overwhelming conflict within the industry, solutions need to be discovered. If we can create designs that can compensate for visual impairments and find ways of assisting those with visual impairments who wish to be

designers themselves, we might begin to see a new spark within the graphic design industry. When thinking about the real world, we also have to consider specific disability requirements implemented by the federal government. According to the ADA (Americans with Disabilities Act), "Products must provide at least one mode that allows access to all functions without relying on users' perception of color." Additionally, "Color must not be used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element" (United States Access Board, 2010). Designers have an immense amount of power; whether it is persuasion through marketing or inspiration from a

more artistic perspective, graphic design is powerful, and such power should also come with a responsibility to promote the growth of our fellow designers and to reach all communities, not just design for those in a perfect world.

We live in a society that is almost wholly engaged, influenced, and otherwise tied to social and web-based media for almost every aspect of our lives, but with such a large emphasis on visual aspects, what happens when one has an impairment preventing them from getting the most out of the web and print media? It is the hope that through this thesis, we will not only find a way to assist better those who have difficulty or are otherwise unable to distinguish between colors but also implement practical solutions to ensure that their visual impairment will not impede their media experience any further.

When thinking about the use of graphic design and its purpose in our daily lives, it is disheartening to think that there are those who, due to visual impairments, are unable to enjoy or are otherwise limited in their ability to use the product to its designed purpose.

"As designers, we should be designing for more than just a perfect world."

How can graphic design be used to help aid those with color vision deficiencies?

This question is the basis of this entire thesis, and while it may appear to be a simple answer, the significance it can have in the lives of so many makes it a subject that should not be carelessly approached. On the surface, graphic design is just that, a visual form of well-developed and meticulously planned communication. However, even with as much thought and design goes into these works, those with visual impairments are neglected. Those with color vision deficiencies are far too common to neglect how the design will be communicated thoroughly. The goal of graphic design is to find more creative and visually appealing ways to convey information effectively; however, if we fail to consider entire groups of our demographics, we fail to communicate and fail as designers effectively. The fact of the matter is that individuals with color vision deficiencies are not entirely void of color except for those with monochromacy, which only makes up only about 0.003% of the male population and 0.00001% of the female population (Kuhn, 2) and even then individuals still perceive color; they perceive one color. This is an aspect that is commonly misunderstood about those who are color-blind. Most would believe that they are, in-fact unable to perceive any colors; we see this stigma all of the time in television, especially when the audience is shown a scene from the perspective of a dog, it always appears utterly void of color, and the audience is left to believe that the color-blind perceive the world entirely in greyscale. The matter is that dogs are dichromatic, which means they have two preceptive cones (blue and yellow) compared to trichromatic humans. This stigma has and continues to cause people to believe that the color-blind are incapable of perceiving colors, and perhaps this is what causes graphic designers to “neglect” those with color vision deficiencies when considering their designs. Knowing that those with various forms of color vision deficiencies can see color should be a game-changer for all graphic designers because it means that we can create designs that can be effectively interpreted and enjoyed by both the average consumer and the color-blind. Using color-blind associated palettes when designing anything will allow us to uphold our ultimate purpose and create more inclusive and practical designs.

What is the most applicable method of implementation for a bridge between graphic design and individuals with color vision deficiencies?

This question is a bit on the loaded side as it suggests that there is a perfect solution to the problem at hand; however, coming up with a solution is not quite so simple. Color vision deficiencies are somewhat complicated, and a viable solution to assist those who suffer from such an impairment cannot be solved so easily either. A couple of approaches to this question need to be considered in bridging these two worlds. The first would be to remove the stigma that plagues the understanding of color vision deficiencies. As previously stated, colorblindness is a seriously misunderstood condition that has almost had a Mandela effect on everyday society for years. Before we can effectively begin to bridge these two worlds, we first must come to an accurate understanding of what color vision deficiencies are and how they impact individuals daily. Once we have a better understanding of what the color-blind deals with and better understand what this condition does, we can begin the second approach to creating our bridge. This next step may not be the most widely accepted; however, it will be essential to make this vision a reality. We must begin to re-educate ourselves as designers. This is not to suggest that we should be completely redesigning the wheel or even throwing out our previous experience and knowledge but instead that we must begin to take our knowledge and experience and begin to view everything through a color-blind filter. This means that we must begin to not treat our color-blind audience as an afterthought or an addendum but to create with them in mind from the start. We will begin to train ourselves to create more inclusive designs but eventually will not even have a separation between the color-blind at all, creating one unified work that does not need inclusivity due to its naturally inclusive nature. Color-blind friendly options would not be necessary because the design would already account for their needs, which would allow those who suffer from these deficiencies to feel a sense of normalcy both conscious and subconsciously.

How can a design effectively communicate the same message to those with color blindness?

Building off the previous question and answer, we begin to look at the outcome rather than the approach. This is essential as it ultimately is what graphic design is all about. Whether you are creating an advert for a local business, an infographic for a non-profit, or even merely just making a fun shirt for an upcoming event, the outcome is the same, to convey some form of information. Where this can become a bit more tricky is our use of color theory. The primary color theory explores the ideas and meanings of colors from a psychological perspective; it is a concept that many people overthink; however, our subconscious mind will always interpret information, and if it can be interpreted, we have to assume that it will be. There is an understanding that everyone has to have a purpose in theatre because everything has meaning. While we may not have any specific intention in mind, our audience may and probably will assign meaning to everything because, as humans, we crave order and purpose even at the subconscious level. Imagine going to an art gallery and seeing a single yellow Lego block on a pedestal. The “creator” may not have assigned any meaning to this exhibit whatsoever, but the ordinary viewer would not know this and searching for meaning; perhaps they would assume that the color yellow represents cowardice and the use of a Lego represents the basic building blocks of our society. This viewer has just decided that the piece essentially means that our society is built upon the fears and cowardice of “lesser” individuals when in actuality, some random kid might have just left their toy on the pedestal. While this analogy is undoubtedly a bit of a stretch, the principle is the same; human nature tends to assign meaning to everything. We can find evidence of this throughout history, such as ancient cultures believing that celestial bodies such as the moon and sun were deities due to their immense power. If everything has such meaning and purpose, would not changing specific colors in our designs accommodate those with color vision deficiencies change the intended message we are attempting to convey? In a sense, it would, however, be where we as designers need to think about our designs in a full perspective rather than build as we go. As previously stated, everything contributes to the message we are trying to convey, from the characteristics of our typefaces to the imagery we are incorporating into our designs. It is the utilization of all of these aspects that will help us to guide our target audience to our intended message and to effectively communicate whatever information we are trying to convey even if we are using different, more color-blind friendly color schemes.



Eyes Are Amazing:
Identegene.com

What are the different types of color blindness, and how can graphic design effectively contribute to assisting those with varying types?

Color vision deficiencies are relatively common, especially in the male population. However, certain types of deficiencies are not nearly as common. What is particularly significant about this question is understanding how this impairment impacts each individual's vision. If we were to assume that everyone who is color-blind is affected in the same way, then we will create an entire system that is only designed to assist certain deficiencies, which ultimately would render the solution to this problem useless. While it is improbable to come up with one solitary solution that will meet every individual's needs, it would negate this thesis's premise to create a slightly more inclusive design solution. To move forward with this idea, we have to consider the different variations of color vision deficiencies and how they change the individual's daily life. As previously stated, the average human or at least one with normal unimpaired color vision is trichromatic, meaning that the eye had three types of cones that each are specifically designed to absorb a different spectrum range of visible light (Rhyne,19). When all three types of cones are functioning correctly, the individual can see all ranges of color uninhibited; however, when one of these cones fails to function correctly, the result can be an overlapping of light spectrum wavelengths, which would cause the individual to be limited in what colors they can perceive. These types can be broken into three categories, Anomalous trichromatic, Dichromatic, and Monochromatic. The three categories are separated based on the number of functioning cones the individual has. All three of these have sub-categories as well, depending on what color spectrum the individual can perceive. Anomalous Trichromatic's are the most common; this is when only one of the cones is malfunctioning. In this category, we have Protanomaly, which causes the individual to perceive the color red more as green. This rarely gets in the way of everyday activities. Deuteranomaly is when the individual perceives the color green more like red. This is the most common of the color vision deficiencies and generally does not impede too much on daily activities. Tritanomaly generally makes it difficult for the individual to determine a difference between blue and green. This is exceptionally rare with both males and females. Moving on to the next and coincidentally second least common category, Dichromatic. This is a result of two malfunctioning cones within the eye. Protanopia is when the red spectrum is completely unperceived by the individual. Deuteranopia is when the green spectrum is entirely indistinguishable. Tritanopia causes the blue spectrum to be completely unable to be perceived by the individual. Monochromacy is the final category and by far the rarest of deficiencies. Monochromacy is as close to the stigmatic perception of the color-blind as it results in a complete absence of color; the cones cannot distinguish between any of the spectrums. However, this is the rarest condition making up only 0.003% of the male population and 0.00001% of females (Kuhn,2). Now that the types have been identified, as designers, we can begin to construct color schemes that allow each individual to perceive the design unhindered by their impairment.

How can companies and other various professions compensate for those with color vision deficiencies?

Contemplating how those with color vision deficiencies and how they work through their impairments within their daily lives, there is perhaps no more important aspect to consider than their work environment. As previously stated, the Americans with Disabilities Act does require specific criteria to be met to make it possible for those with CVD to be able to do their job adequately; however, these requirements, for the most part, are to ensure that color is not the only means of communication. In the process of trying to assist those with visual impairments in the workplace, they negate the need for any preceptive color. While this may be the right solution for ensuring that the individual can effectively do their job, it can still be improved upon to meet a bare minimum requirement and help make their lives more efficient. There are many professions that an individual with color vision deficiencies would be ineligible for, such as certain scientific positions and careers such as being a pilot; however, there are steps that even theses careers could take to make it possible for impaired individuals to be able to find a place in their ranks. As we have already explored, Color-blind individuals can still perceive specific colors, and they are, for the most part, efficient color palettes that can be perceived by each form of color vision deficiency. If we could add new requirements for companies to utilize these specific colors, then we could see previously inaccessible career paths for the color-blind open up. Perhaps it could be built into whatever software the company is required to use that is color driven; the software could have an option to translate the colors into a color-blind friendly scheme. Alternatively, maybe it is physical equipment, instead of building them with red or green indicators, they could use colors that fit a universally accepted spectrum like orange and purple. This could be mutually beneficial to the individual with the deficiency and the company that might be gaining their best employee due to compensating for their needs, not to mention the extra drive the color-blind individual might have from understanding that a company has thought about their needs. The downside to this would be finding a way to meet the needs of those who suffer from monochromacy. Unfortunately, this solution would not be viable for their needs.

How do color vision deficiencies prohibit an individual's perception of media in various formats?

The answer to this question is seemingly simple at first glance. The lack of color perception will cause difficulty in any individual's every-day processes; however, it goes a bit beyond that. First, the media format makes little difference for the visual impedance, where formats will come into perspective with the methodology in which the visual solution will be derived. When considering the daily difficulties of an individual with color vision deficiencies, it is essential to think about all of the small visually-driven tasks that we take for granted every day. For example, when getting dressed in preparation for the day, can we clearly distinguish between the fabric's specific colors in our ensemble? An individual with a color vision deficiency might not distinguish such colors and wear an outfit that clashes. While this usually would not be much of a hindrance, if said individual was going to a job interview, this might reflect poorly on the would-be employer's first impression. Regarding media that the color-blind individual might run into, we can see that difficulties could arise on a more theoretical level. If the individual works in the marketing industry, they may end up using colors that would convey an unintended meaning or otherwise invoke undesired feelings from the intended audience. Perhaps the color-blind individual works as a teacher and accidentally decorates their classroom in a rival school's colors. Furthermore, if the individual is given simple tasks like "pass the red pen" or "sign on the blue line," they may not aptly accomplish these tasks depending on their deficiency and severity. Ultimately, whether it is impeding their ability to perform daily or merely just inhibiting the individual from enjoying everyday media such as magazines, photos, and television, the lack of distinguishing between colors can be a life-changing impairment.

What technologies already exist to help merge graphic design with those who have visual impairments?

The needs of the color-blind is a problem that has been considered and toyed with by others; it has never been a serious issue for a lot of business. Some creative studios have incorporated these needs into their work, such as EA. Electronic Arts is a relatively well-known video game studio that has produced several popular games, and they have at times incorporated an option into their games where you could select your type of color deficiency, and it would change colored objective markers to one that could be perceived by your specific condition. This is a spectacular and innovative contribution to the community that plays their games, but what about creative industries creating digital and print media? How could graphic designers incorporate this kind of technology into their work? Fortunately, this is something that Adobe has already put a fair amount of effort into implementing. Adobe is by far the industry standard for virtually anything creative, and indeed for graphic designers, this software is essential. Understanding that color vision deficiencies are a very real and active problem that designers face or at least should consider, they have created a few aspects to their software that assist in this area. First, they have brief yet concise informational pages on their site that give insight into the different types of CVD and how to create in their software efficiently with that in mind. They teach you how to create color-blind safe themes that you could use in all future designs on one page. Additionally, they have conflict guides that will show you where problematic colors might be when selecting your palette. Creating these ahead of time would save you time in the future and help you continue to create more inclusive designs. Second, Adobe has also created CUD (Color Universal Design) that gives the designer tools such as color-blind filters, allowing you to overlay on your design to see how color deficient individuals would see your design. This also allows for soft-proofing for color-blind inclusive designs. These are features that should be significantly considered by any individual who will be utilizing the Adobe software.

What limitations are preventing graphic designers from adequately assisting those with color vision deficiencies?

While many limitations can all be varied based on the individual's specific needs, the reality is that from a graphic designer's perspective, the only major limitation is a lack of knowledge about how to compensate for various color deficiencies. As we have already seen, various forms of compensation already exist in the world to assist those with these visual impairments, but we still find far too often that designers are working without even briefly considering the visually impaired needs. For the most part, this is unintentional, but one has to believe that if the knowledge of these tools and methods of creating more inclusive designs were more common, then the designers would create with the visually impaired in the forefront of their mind. After all, designers are continually striving to create something, not for their enjoyment, but for the enjoyment of others; their audience is always their basis for the creation, and given the opportunity to create more universally acceptable designs regardless of the impairment would be an option that is likely to be favored by all designers. All things considered, when it comes to individuals who suffer from monochromacy, no amount of knowledge or expertise with these tools and techniques will be able to assist. Ultimately, the most devastating limitation for designers is the lack of ability to compensate for totally color-deficient. Again, this is an extremely rare and minimal margin of individuals to consider, but they nonetheless need to be considered. At the current moment, it does not appear that there is a viable solution for these individuals.

How can those with visual impairments who have a desire to be graphic designers be adequately assisted?

This thesis's central premise is to help encourage designers to help those with color vision deficiency by creating more inclusive designs; however, a secondary objective is to encourage those who are color-blind to pursue a career in graphic design choices. As previously stated, it is a shame to just eliminated individuals from their desired career path simply because they have a color vision deficiency, especially when considering that desire for a career path often translates into the individual being exceptional in the field. To think that we might be losing the next Paul Rand or Saul Bass because they do not believe they can work in the field or they are limited in assistance to accommodate for their needs is a real tragedy. After all, how many of the greatest creators in history went on to excel despite a crippling disability. From blind blues musicians to deaf musical composers, there numerous accounts of individuals who should not have been able to perform in their perspective fields due to their impairments and yet they are unparalleled in their ability. Making features that already exist such as the features Adobe has incorporated into their software along with easy and accessible reference materials such as what is being proposed as the visual solution for this thesis will give those individuals who may feel like their visual impairment will impede on their ability to become an efficient graphic designer the knowledge and hopefully the encouragement needed to help them to pursue such a career.

What is the most cost-effective method for universally assisting those with color vision deficiencies?

In the previous question, we explored the idea that companies and other professions could use different color palettes to help compensate for those with color vision deficiencies; however, everything sadly always comes back to cost in the business world. While this may not define how much they care about their employees, they must remain profitable and fiscally responsible to survive. It would not serve these companies well to spend profit margins on the EnChroma glasses for any color-blind employees or pay for what will inevitably be costly and risky surgeries to compensate for their impairment. This is precisely why reformatting the way these companies and career paths use color would by far be the most cost-efficient. At most, this could be the cost of a training seminar, perhaps for their HR department or information supplements used as a reference point. The visual solution discussed later in this thesis will be to create reference materials that would be easy and universal for all career paths. These materials would contain overly simplified information of specific color vision deficiency types and what palettes can be used in place of the problematic color. What would make this efficient would be the versatility of the product and its cost-efficiency as it would only cost what it takes to produce the material. In this sense, you could eliminate the need for any specialized training. It would undoubtedly be cheaper than the cost of any special equipment like the EnChroma glasses. This would also be beneficial as it would benefit the employee and be beneficial for any clients who might suffer from a color deficiency.

2.

Understanding Color Vision Deficiencies

NORMAL VISION

DEUTERANOMALIA

TRITANOPIA

PROTANOPIA

“Many People are under the the misinformed idea that colorblindness is a universal lack of color.”

Visual impairments are a common problem within our society; when thinking about how it impacts the graphic design industry, our loved ones, and those we surround ourselves with, we can see how necessary it is to find an excellent way to fit their needs. We do not always understand exactly what they are going through or how these impairments may impact their daily lives. For example, many people are under the misinformed idea that colorblindness is a universal lack of color within their sight, when, in fact, there are several variations of colorblindness that affect individuals differently. Two of the most common variations of colorblindness would be protanopia and deuteranopia, which cause the individual to be unable to perceive shades of red and green; however, the eye still sees other shades of colors, and the brain will try and compensate for the lack of red or green with other colors (Wong, 441). It is essential to understand just how these disabilities impact those who have them daily and find adequate solutions to assist those with visual impairments to understand the impairments themselves better.

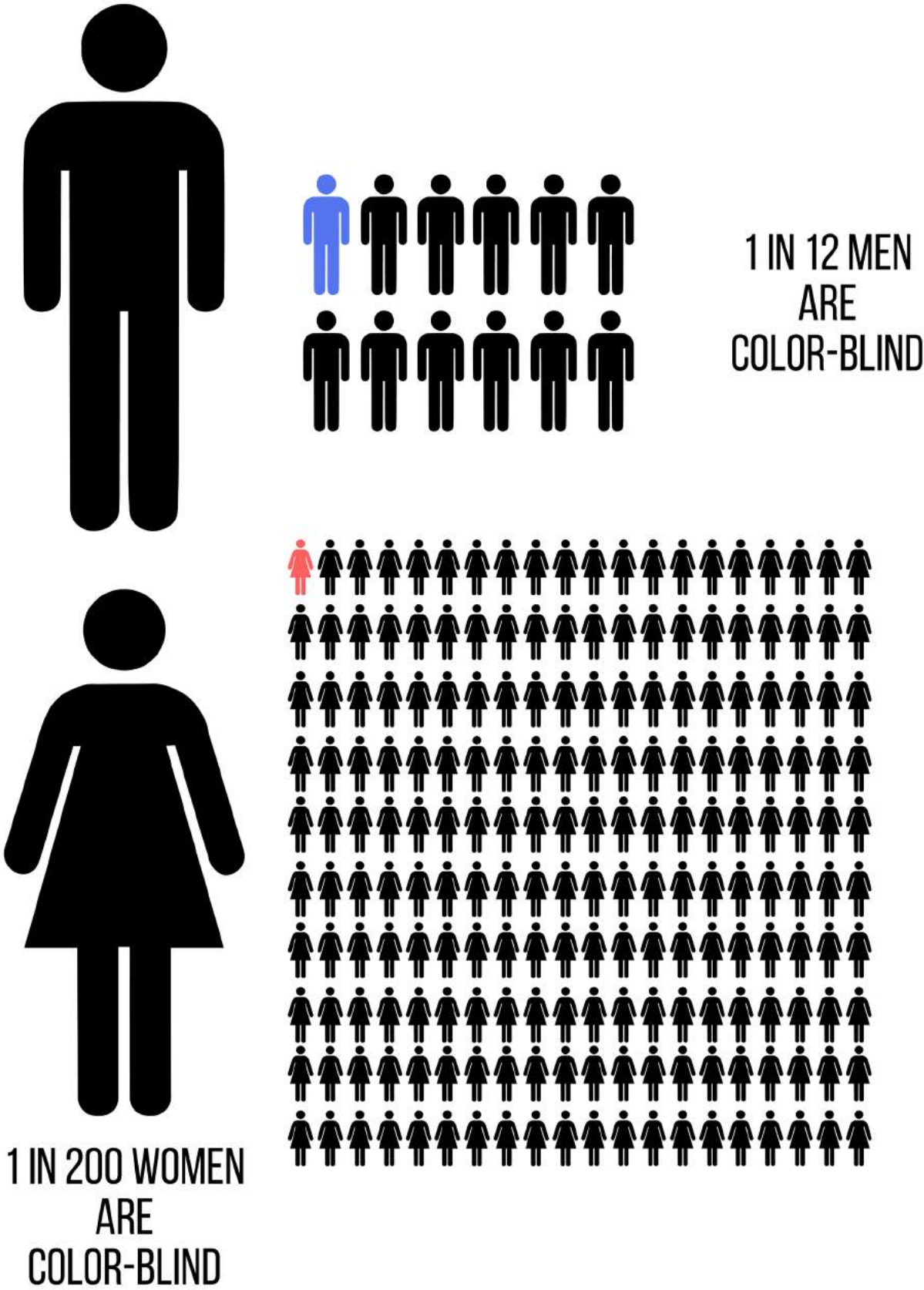
In this section, we will look at the medical side of color blindness to better understand how we can design specifically for said impairment. When considering the implications that color vision deficiency or CVD has on society as a whole, it is relatively easy to pass those with color deficiencies off as an anomalous rarity and focus on what is visually appealing to the majority; however, this is like predicting the weather

for a neighboring state based off of the current conditions in our immediate location. As designers, we can not fall under the unintentional, seemingly universal understanding that all of our designs will be perceived in the same way that we see them. The human eye is extraordinarily complex, and by association, the complications and ailments that may impact the human eye are equally as complex.

As previously stated, colorblindness is a somewhat misunderstood concept, largely impart of its very name. Most would believe that color blindness would mean being unable to see any colors. The image most have in their head when they think about being color blind is of old black and white movies. This noir style understanding of colorblindness is shared with the majority of society; even famous cartoons have portrayed the perspective of colorblind individuals in shades of grey; however, this is far from accurate.

Color blindness limits the individual’s perception of specific colors, but not all colors. This essentially means that they can see specific colors, but when they come across a color affected by their impairment, they cannot distinguish it from another color that they can perceive; it would appear as a similar shade of perceivable colors. Color blindness is an inherited deficiency that is significantly more common than one may think. Approximately 1 in 12 men and 1 in 200 women suffer from some form of colorblindness worldwide. At first glance it may seem shocking that there is such a vast difference between the statistical probability between

men and women; however, scientifically, it is quite logical. The genetic defect of color vision deficiencies is passed down through the x chromosome. Men genetically carry the XY chromosomes where women carry the XX. If a female were to inherit the genetic defect by chance, they have approximately 50% chance for the body to correct this mistake, whereas in a male, if the CVD defect is passed, they will inherit it (Simunovic, 747). Worldwide, it is believed that around 300 million individuals suffer from color blindness, which is almost the entire population of the United States (Wong, 441). Being such a common issue, the very fact that we do not consider those with color blindness more when designing content is somewhat alarming and limits us from creating the most accurate and inclusive designs possible, especially when you are to consider what can be done. Color blindness again does not limit the individual from seeing all colors, but perceiving certain shades, this can somewhat easily be fixed by working with more inclusive palettes to meet the needs of those with impairments, which is a concept that will be explored later in this paper.





“Humans have a propensity for coming up with creative solutions to our issues.”

Technologies & Methods 3.

What is currently being done for the color-blind?

Over the years, new technologies and methods have been created to assist those with visual impairments in various life avenues. As designers, we should be utilizing these options to their fullest potential to ensure efficient communication within our designs.

Understanding the different visual impairments and how they impact the individual is crucial when considering how to assist said individuals. However, to neglect to look at what methods are currently being used to assist those individuals and what technology currently exists to help would be a tremendous mistake. The fact is we have been trying to come up with viable solutions since we began to understand what visual impairments were impacting society. One such example would be Benjamin Franklin and his creation of the bifocal; being both near and far-sighted, he created a version of correctional lenses that would meet both issues' needs rather than one or the other. Humans have a propensity for coming up with creative solutions to our issues, it is embedded in our very nature to have a strong desire to create, and when presented with a seemingly unsolvable issue, we tend to ignore the “impossibility” and create something to compensate. Over time and more understanding, we have even come better to understand more efficient testing methods for color deficiencies. In John Mollon's book *Normal and Defective Color Vision*, he explores several different testing methods, one of the most common tests based on the pseudo-isochromatic (PIC) principle (Mollon, 341). The idea behind this test is relatively simple, by using a series of colored dots, a subliminal image could be placed within the overarching image that is composed of colors that would appear to be indistinguishable to those with CVD, simply put, if you cannot see the image, there is a strong chance that you might have a color deficiency.



As we begin to delve more into this technologically advanced and media-driven world, it is more important now more than ever to consider those with visual impairments and in order to do so, we need to look at what has already be done and is currently being done to assist those to the best of our ability. Especially when considering graphic design, both from the perspective of the consumer and designer, it is essential to look at all possible methods. As previously stated, graphic design has a unique power that can be used in so many ways; when we fail to use such abilities to assist part of our population, to some extent, we fail as designers. While this is not to suggest that every individual that designs a poster for a new Barbie doll has failed because they did not consider the 87-year-old with glaucoma and cataracts who is unable to read the text, we do have to consider the fact that there may be a portion of our target audience who may be suffering similar symptoms.

There are many aspects to consider when looking at cvd's or any visual impairment, for that matter. Is this impairment brought on due to a preexisting condition or another ailment? Is the condition hereditary? Could the impairment be due to an injury? The list goes on and each question brings a whole new perspective on an appropriate approach to a viable solution. Over the years, we have certainly seen a number of aspects in an attempt to identify and overcome these visual impairments. One of the most significant aspects of font development is that it is applicable for both print media and digital designs. Over the generations, though, typefaces have been created to fit specific needs, such as creating sans-serif typefaces to create increased legibility for the users while maintaining modern style and applications for creative outlets (Jakoubě, 10).

As for those who suffer from color blindness, there are not many intricate tools or methods to choose from. However, this is perhaps the easiest visual impairment to use graphic design for accommodations. Color blindness is usually caused by malfunctioning cones causing color wavelengths to overlap each other, causing the individual to distinguish between specific colors, most commonly red and green (Robledo, 3). As previously stated, options for correcting this overlap are relatively limited; some experimental procedures have only been tested in mice but showing promising results. The EnChroma glasses have become quite popular in recent days, primarily due to a large number of viral videos showing individuals who suffer from color blindness putting the glasses on, allowing them to distinguish between colors for the first time. These glasses are indeed an exciting advancement in the area of color blindness, “according to the manufacturer, EnChroma filters tend to decrease the overlap between M and L cones spectral sensitivity” (Robledo, 3). This means that the glasses help compensate for the overlap, basically filtering out the duplicated wavelength, allowing them to see the accurate colors. While this is an outstanding advancement, it may not be the best option as the glasses do not work for every individual, nor

are they the most affordable option. Cost is an important aspect because if we only are able to deliver a solution to those who are fotunate enough to be able to afford sugeries and glasses, then we haven’t fixed anything, at best we have afforded enhanced vision for a few fortunante individuals.

Aside from experimental surgeries and costly glasses, there is another option that has become more popular with video games and some applications but remains severely underused by designers and individuals working with various visual communication forms. As previously stated, color blindness is an overlapping of specific color wavelengths that keep the individual from distinguishing between certain colors, most commonly red and green. Since these colors can not be distinguished, they can be switched with similar colors that can be distinguished. For example, in some cases, red could be traded for magenta, and green can be traded for turquoise to allow for better visibility for most with color blindness. However, there are different color blindness variations, so these colors may not be universal for all; that being said, the concept should be applicable for using different variations of alternative colors. What makes this such an exciting concept to explore is that it can create a more inclusive world. As designers, it is our job to find the most visually appealing, but the most effective ways to communicate information, ergo, is also our job to work toward our audience's most inclusive designs.

“It is our job to work toward the most inclusive desgins for our audience”



Hands, Globe, Color:
By Twenty20Photos

Correcting the Issue

4.

What can we do to assist the visually Imapired?

As designers, we have not only the power to reach the masses but an obligation. Imagine a doctor who continuously neglects a whole demographic; it is unheard of. As we continue to create, we should be focusing on more inclusive designs to ensure that all take in our work.

Having explored the variations of color vision deficiencies and some of the methods and technologies used to help compensate for them, we now look at the best possible solutions for utilizing graphic design to create a more enjoyable media experience form both print and digital media. This thesis’s ultimate objective is to provide the most impactful media experience through graphic design; this is for both the consumer and the designer alike. It may seem a bit redundant to use graphic design to assist graphic designers; however, it is essential to make sure that those with visual impairments are not alienated from the industry. With the commonality of specific visual impairments such as color blindness, there are likely to be several individuals who live with such an impairment that desires to work in the design industry and be told that it is impossible due to their condition is a real tragedy. The fact is that several occupations consider impairments, such as color blindness, an impermissible condition. Perhaps methodologies that would allow an individual to work in graphic design without issue could open doors in other careers.

Considering those who suffer from color blindness, we are looking at a large portion of our population, at least more extensive than most realize. This is perhaps the most meaningful perspective for me throughout the thesis, as growing up, I had a friend who suffered from deuteranopia and always had a desire to be a graphic designer. However, due to his condition, he was told that he would never find success in the field and was convinced to pursue other career options. Graphic design is perhaps one of the most exciting and enjoyable career choices for creatives; at times, it feels as if it is the Super Bowl of the creative industry. To have that desire and be told you cannot pursue it is heartbreaking. What can be done about color blindness? As previously stated, there are the EnChroma glasses, which are expensive and not universal. There are experimental surgeries, but they are not ready for human trials yet, which could be some time, not to mention the expense. However, the best option for those with color blindness is much more straightforward. While it is true that those who suffer from color vision deficiencies are unable to dis-

tinguish between specific colors, they are not limited by all colors. It is a common misconception that color blindness removes an individual’s ability to see any colors when it merely causes them to see specific colors as the same (reds as greens or vice versa). However, this can easily be solved by replacing the problematic color spectrum with a color palette that is more acceptable to their condition (Wong, 441). Services have already begun to use this as an option; many video games that use colors for objective markers have color blind options built into their programming accessible through the options menu, allowing them to select a palette that better suits their needs.



Question Mark on Pink Background:
By Rawf8

To incorporate this into a more suitable format for both the consumer and the designer dealing with some form of colorblindness within their life, I propose creating a series of colorblind-friendly palettes following the conventions of color theory. Several formats could be used to convey this information, posters, prebuilt color palettes for software such as Adobe Illustrator or Photoshop, but perhaps the most convenient would be a cheat sheet index card or cards. This would allow both the

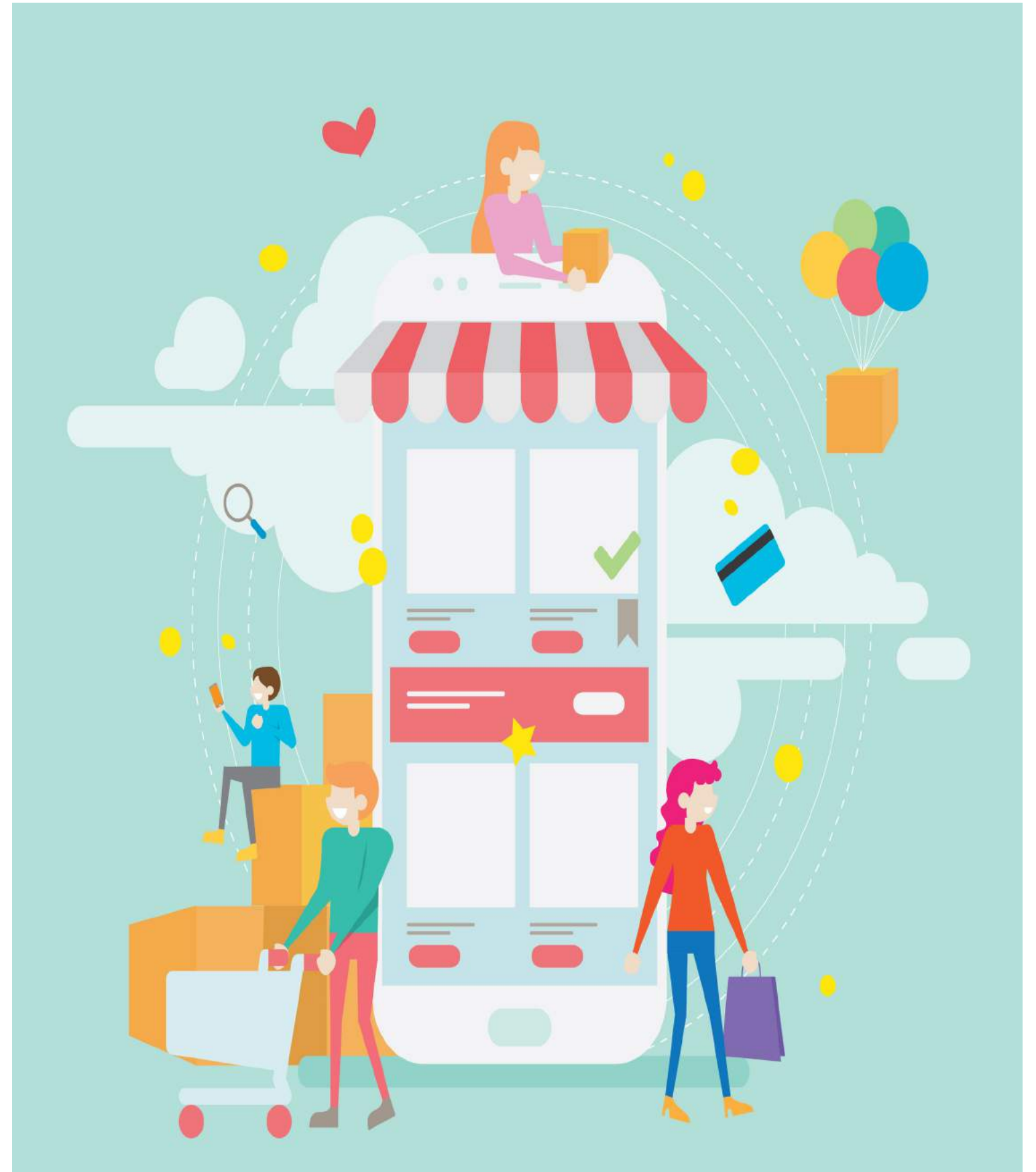
“It is essential to keep the color-blind population in mind when creating designs”

designer creating with the colorblind consumer in mind or the designer who suffered from some variation of color blindness not only to see what colors they can choose from but give them the bonus of incorporating color theory into their design by providing detailed information about how to apply that palette into their design. These reference cards could have various color schemes (analogous, complementary, etc.), but rather than focusing on the primary colors, it could give examples of colorblind-friendly palettes based on the user’s need. They can be designed to fit the user’s needs based on the varying types of color blindness, and the palettes would fit the need for that specific type. To encourage the use of said colors, information like the hexadecimal code and examples of use could also be incorporated into the reference cards.

As previously stated, graphic design is powerful. In many ways, it can allow individuals the power to create new perspectives on our surrounding world, convey a specific message to an audience, and invoke powerful emotions. The very fact that we far too often neglect such a large portion of our population is rather shocking, especially when the solution is as easy as rethinking our color use. The designer needs to keep the colorblind population in mind when creating designs, and I believe that something like these reference cards could play a pivotal role in the re-evaluation

of our design process in consideration of our color blind consumers. Furthermore, it can provide a quick reference point for accurate and usable options for the colorblind designer allowing them an additional tool toward their success in a career in the graphic design industry.

Lastly, we live in a digital world. In an era where even newer technology like Bluray discs are becoming obsolete due to the increase of streaming services and all digital formats. In the midst of this transition, creating viable solutions in the analog or physical state would be a monumental mistake. While these visual solutions are practical and would undoubtedly be a considerable asset to assisting designers in creating more inclusive designs, there is a distinct lack of technological evolution that could lead one to believe that these solutions’ lives may not be as long as expected. In this sense, the creation of some form of a digital tool would be essential. While this could come in many different formats, such as entire websites dedicated to this problem, the most viable solution would come in a phone application format. Cellular technology has come so very far and does not show any signs of slowing down. To think that our modern smartphones’ processing power is significantly more powerful than the computers that put a man on the moon is astonishing, making it the logical choice as a digital delivery system for a visual solution. As previously stated, the largest contributing factor would come down to the education of the subject matter. Most designers do not neglect the color-blind simply because they chose not to, but rather because they either did not think about it or did not understand it. Imagine an application at your fingertips that could teach you about the specific visual impairment and provide you with sufficient resources to help compensate for the issue, and perhaps even provide a community where other designers could work together to create the most inclusive designs possible. We would create an effective solution and continue building on a community that would help progress this idea into the future to reach its fullest potential. This is the idea that will help take the entirety of this issue and give an option for correction and provide designers with inspiration and other tools that they would use daily, centered around enhancement for the color-blind, therefore increasing the outreach and inclusivity of our designs.



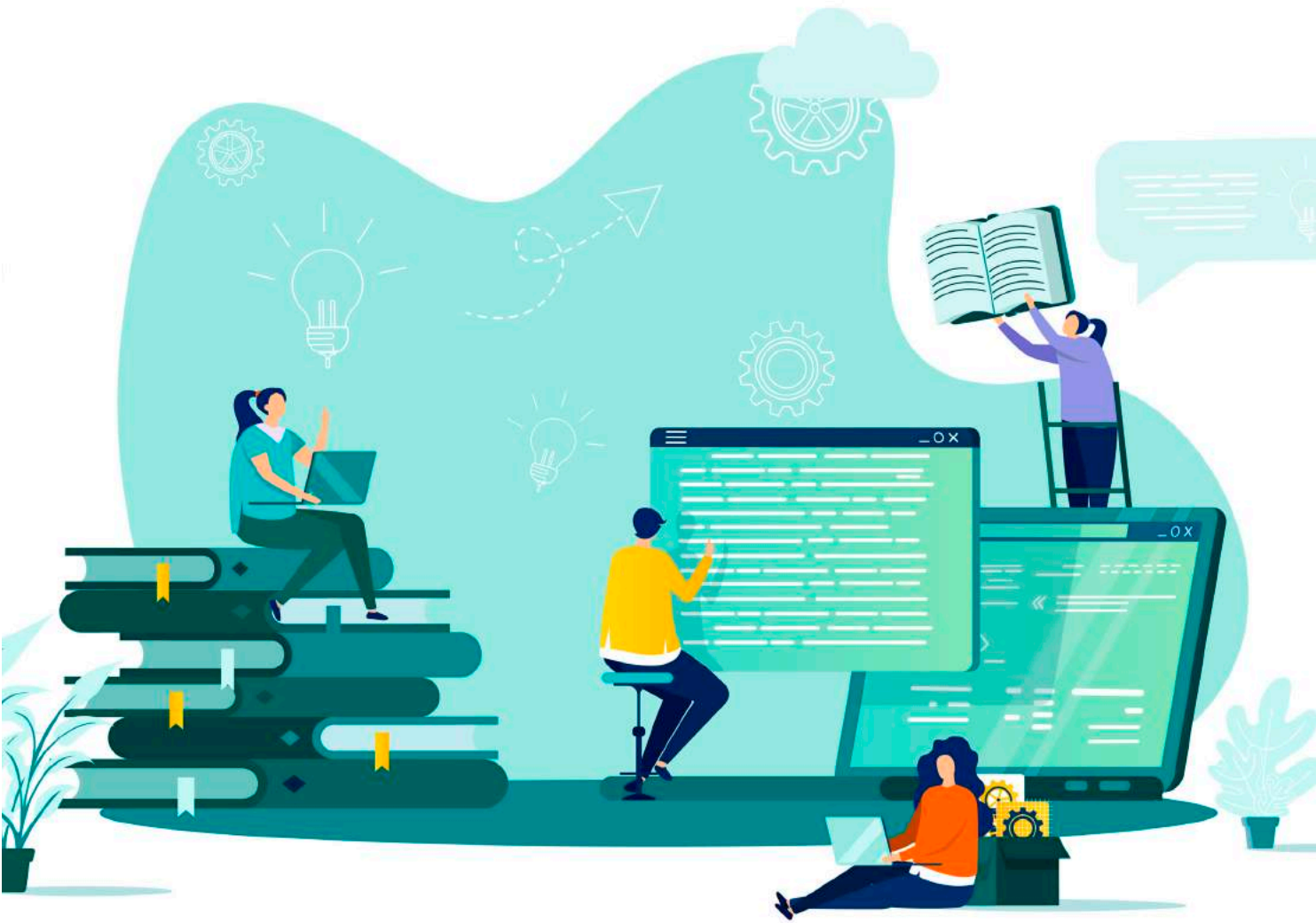
5. Additional Research

Knowledge Gap

While many limitations can all be varied based on the individual’s specific needs, the reality is that from the perspective of a graphic designer, the only major limitation is a lack of knowledge about how to compensate for various color deficiencies. As we have already seen, various forms of compensation already exist in the world to assist those with these visual impairments, but we still find far too often that designers are working without even briefly considering the visually impaired needs. For the most part, this is unintentional, but one has to believe that if these tools and methods of creating more inclusive designs were more common knowledge, then the designers would create with the visually impaired in the forefront of their mind. After all, designers are continually striving to create something, not for their enjoyment. However, for others’ enjoyment, their audience is always their basis for creating and allowing to create more universally acceptable designs regardless of the impairment would be an option that is likely to be favored by all designers. All things considered, when it comes to individuals who suffer from monochromacy, no amount of knowledge or expertise with these tools and techniques will be able to assist. Ultimately, the most devastating limitation for designers is the lack of ability to compensate for totally color-deficient. Again, this is an extremely rare and minimal margin of individuals to consider, but they nonetheless need to be considered. At the current moment, it does not appear that there is a viable solution for these individuals.

“

The only major limitation is a lack of knowledge about how to compensate for various color vision deficiencies





Stake Holders

As far as who would be affected by my research, I believe that it could have vast implications outside of the realm of graphic design, as visual impairments are an issue in numerous other avenues of life, there are two main groups that I am focusing on. Both of these groups seem a bit generic on the surface, but that doesn't change the fact that they are the groups that need to be addressed. The first group would be those with visual impairments, which in the viewership of graphic works. This group would focus heavily on the audience's standpoint, using graphic design to assist those who have visual disabilities from the viewers' aspect. The second group would focus heavily on those with visual disabilities from the creator's perspective. This group is far more significant as there are so many people with visual disabilities who desire to work in the visual arts but don't because they feel as if they cannot. If this research could be used to help find a way to bring more people into this beautiful field that previously thought it impossible, then it is research worth doing.

"So many people with visual impairments believe it is impossible to become designers."

Graphic Designer Giving Presentation:
By Wavebreakmedia

Graphic Designers at Work :
By Seventyfourimages

Customized Office Workspace:
By Stokkete

6. Design Proposal

Understanding how visual impairments such as color vision Defecncies work and how they might be treated, while necessary, it is only half of the battle. Thus far, we have only explored this issue from a theoretical and observational perspective; both wasted if not used in conjuncture with a practical aspect. To truly help solve this issue, we must look at how we can practically apply this information and provide a real-world working solution so that we can transition to more inclusive designs. Deciding as to what the visual solution needed to be and how it needed to function was undoubtedly a challenge, but this is to be expected as it is a challenging subject. To properly come up with a viable solution, the problem needs to be simplified and accurately identified. The primary issue is that those who suffer from color vision deficiencies are not even considered during the design process, making it

considered during the design process, making most designs difficult, if not impossible, for them to view with the desired outcome. To correct this, I propose a series of reference materials specifically designed to encourage a stronger focus on those who suffer from color vision deficiencies. Designers often use various tools and techniques to aid them during the design process by creating materials that could easily be incorporated into the designer's tool belt; hopefully, they will be more inclined to create visually impaired minds.

As previously stated, I hope to achieve with this visual solution to help inspire a generation of designers that creates more visually inclusive designs so that we can effectively communicate with all individuals despite any impairments they might have. By creating reference materials, it is the hope that this will help graphic designers have some good color schemes and data that they could use in their designs regardless of the visual impairment, but by using color schemes that are intended for the color-blind, you will get the bonus of providing more inclusive palettes. Initially, I had planned on the visual solution coming in two deliverable methods, a large poster (24"x36") and a series of flashcards (3"x5"). However, the flashcard idea proved to be less valuable than initially thought. Additionally, I wanted to create some form of a deliverable in a digital format, so I decided to incorporate an app. The poster I believe, would be visually appealing but could be a quick reference piece that can be mounted on the wall nearby and contain all information that might be needed while making inclusive designs. This would have information that would break down the different types of color deficiencies, colors used in place of the desired color, and some good color palettes for each type of deficiency. This would also include color theory information such as color relationships with color-blind friendly palettes,

color wheels, and inclusive color schemes. All would also include hexadecimal codes for the corresponding color, to make this not only visually appealing, but again a commonly used reference material to encourage use and therefore encourage the creation of more inclusive designs. The flash cards would have been similar in nature, however the poster would be designed to be a one stop shop for quick reference to all that they may need for creating inclusive designs, wheras the flash cards would be more minimal referencing only one color or palette. Through this process I toyed with exactly what information I wanted to include for the cards, I tried to have on one side a single color-blind friendly color and hex code, but when flipped would have had a few color palettes that could be used in association to this specific color. This would have allowed the designer to look through and find a color that grabs their attention and then have quick reference to complementary colors and useful palettes for said color. This became more complicated than I desired though as I progressed forward. So I transitioned the flash card idea into something that was a little more simplified and still remained useful. Pantone books are an incredibly useful tool for any designer, as they not only provied a simple visual color selection, but provides useful information like the hexadecimal code as well for quick use. As I realized that the flash cards wouldn't have the desired impact, I decided to make a color-blind friendly version of the Pantone books, three different books with color scales of prminate colors that are easily visible to that specific defecney.

During the process of developing viable solutions to this problem, I wanted to incorporate a digital tool that could be used in the office, at home, or wherever the individual might be. This is what led me to the app idea. The app would be relatively streamlined, as to not overly complicate things. The idea is to have something that could have some simple instructions and buttons that would allow the user to select the type of CVD they are working with and then use sliders to show what an image would look like in normal vision vs that specific deficiency. I would also like to incorporate an aspect of color blind friendly palettes into the application as well. The combination of these deliverables would function distinctively on their own, but can also be enhanced by the other if the designer were to use them together. Additionally, the nature of these products would is something that any designer could find use for regardless of its intended focus on the color-blind audience, however given the fact that it would be designed to include the color-blind audience, it would automatically help designers create more inclusively.



7. *The Design Process*



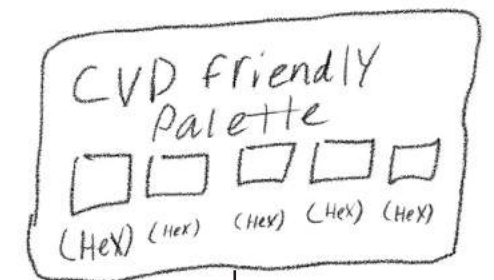
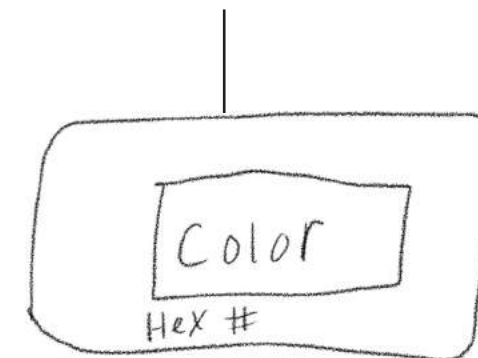
The Failed Flashcards



When I first began thinking about how effectively to create a proper visual solution to my problem, I approached it with the idea of creating something practical while remaining unique. I decided to go with a flashcard style item that I believed would have much value. It would be a fun way to provide adequate detail and have a bit of fun because, after all, everyone loves cards. This approach seemed simple enough at first, but as I began to think about a practical design actually, I realized that it would end up either being overly simple, to the point of it having no use, or it would be so confusing and complicated that the user would never find a practical use for it. The first thought was to create a card for the specific color impacted by each specific deficiency on the front and a sound color palette on the back that could be used for that type of color blindness. However, this would only produce at best six cards, and only three that would be viable. The second thought was to have a series of cards with random color that is difficult for individuals with a specific deficiency, and on the back again, a palette works in place of that color. The problem with this idea, though, is that because there could be an overabundance of cards, it would get too complicated, and there is no system of organization, and if the individual were to mix up the cards inevitably, they could spend far too long trying to find the one they are looking for. Furthermore, having an unusable color on the front may not communicate information in the desired format.

Deliverable - Flash card

The front side would have been designed to show either the primary color that is difficult to see by a specific CVD type or a random color that is difficult to distinguish.



The back would have been designed to provide the user with an acceptable palette to use in place of the unperceivable color

Flashcard Digital Iteration

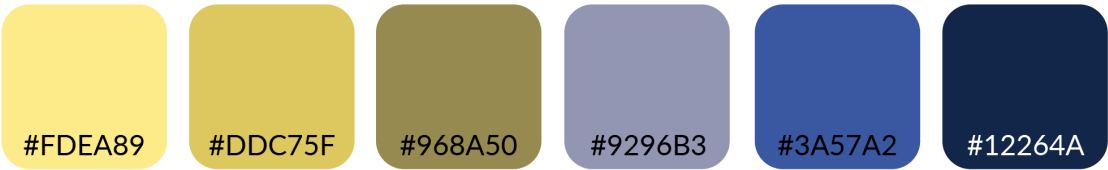
This idea was abandoned pretty quickly into the design process as I learned that it had no practical use in its current format.

Protanopia



Designing Clarity

Colors to use instead



I would like to continue to work with this idea so that maybe with some refinement, it could be turned into a working solution.

Designing Clarity

“Failed data is still good data. The success of a project is not determined by the number of successful outcomes, but how you respond to failure itself.”

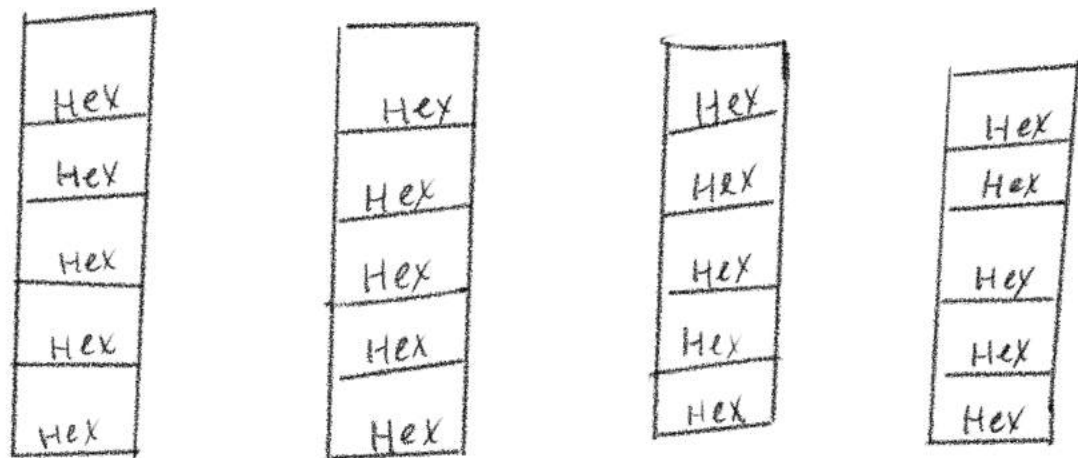
Color Guides (Pantone)

Upon realizing that the flashcard idea wasn't going to work. It was clear that the idea needed to be rethought to come up with a viable solution that could take its place. While I was considering a viable solution, I began to think about what tools are useful and common for designers outside considering those with

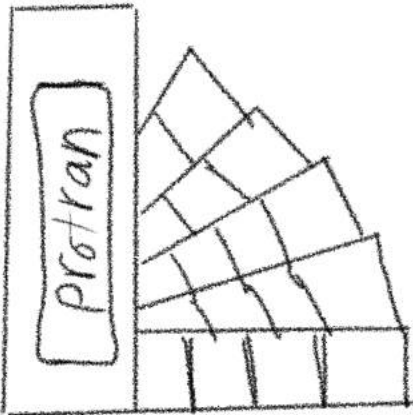
color vision deficiencies. This brought me to the idea of a Pantone book. This kind of book has been used in numerous areas outside of even graphic design as they are commonly used with paint examples, it is used to help showcase gel colors in a theatrical aspect, this list can go on and on. As a designer, though, this is a simple idea that is readily at hand and is an absolute staple of the design process. There is no doubt about the importance and successful use of color guides such as the Pantone books; however, I noticed that there were no specific to color-blind friendly colors. This opened up the possibility that this could be a useful solution to the problem at hand but has no direct competition making it somewhat revolutionary to the field. This was both exciting and a bit disheartening. The excitement obviously comes from the idea of a new and relatively original solution; for the first time in the process of coming up with visual solutions, it felt like everything was going in the right direction. Though, the disheartening part reinforced what I had discovered in my research: for the most part, designers daily are not even considering those with visual impairments, particularly those with color vision deficiencies. However, this only served to reinforce the importance that this work needs to be done to be more inclined to create more inclusive designs.



Deliverable - Pantone



A large part of what drew me to the idea of a Pantone style-book is it would retain the original flashcard idea's practicality while simultaneously fixing all of the issues that came with the flashcards. As you can see, the cards would have a series of scaled colors, each with a corresponding hexadecimal code for quick color selection, making it not only suitable for visually identifying your desired color or color palette, but also have the code that could be quickly typed into whatever program you are working with. Additionally, I had considered a QR code identifier to help speed up incorporating the color into the digital format, but this did not seem practical since it is only useful to cell phones and tablets.



This solution would also fix the severe lack of organization that the flashcard idea had the potential of creating. With cards, it is easy to get them mixed up or even lost, but with this idea, the cards would be bound in a specific order to keep them in order and help prevent them from getting lost. The books would be bound by a key ring so that it could be easily mounted nearby in one's office space for quick and easy access.

Color Blind

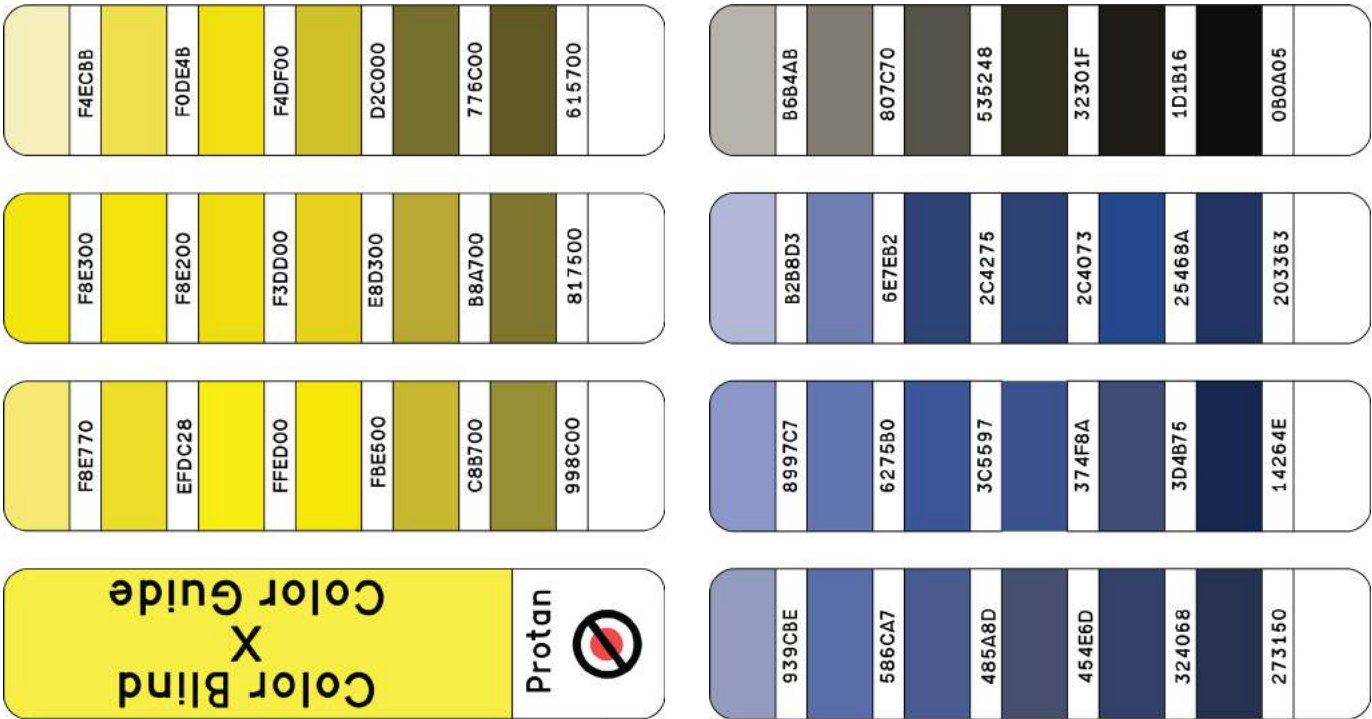
X

Color Guide

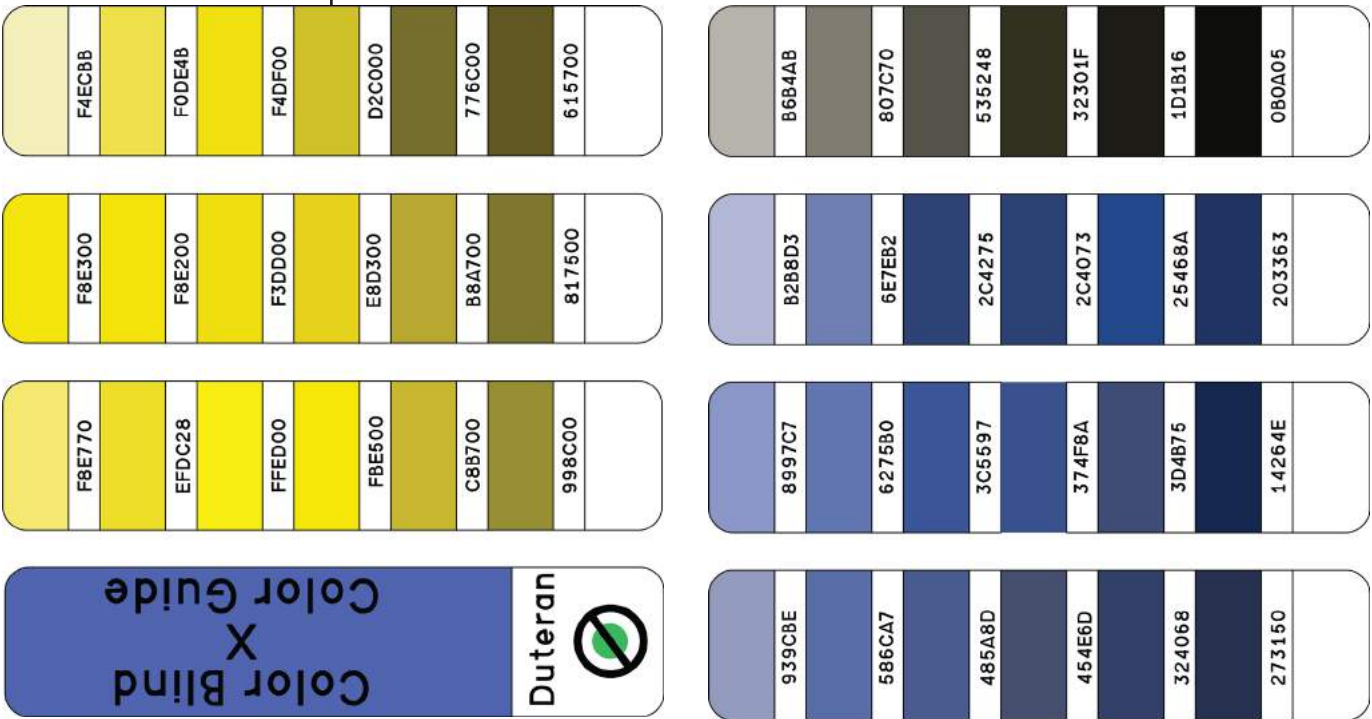
Tritan

CA578C	D1928E	E5B6C5	00BDE1	00D4F8	99DBEF	5384A3
BD4974	C1799F	DC97AA	03A9BF	01BDD1	8BC7D6	477389
A10639	BD055D	C33253	028F99	02A5AD	71A6AF	3B5F6D
7C050D	A30322	A20215	097477	059191	5B8589	2C464E
550009	92001F	760206	065D5F	057774	3E5B5C	1F2E33
2C0102	5F0009	720B29	065454	044744	243836	162023

Designing Clarity



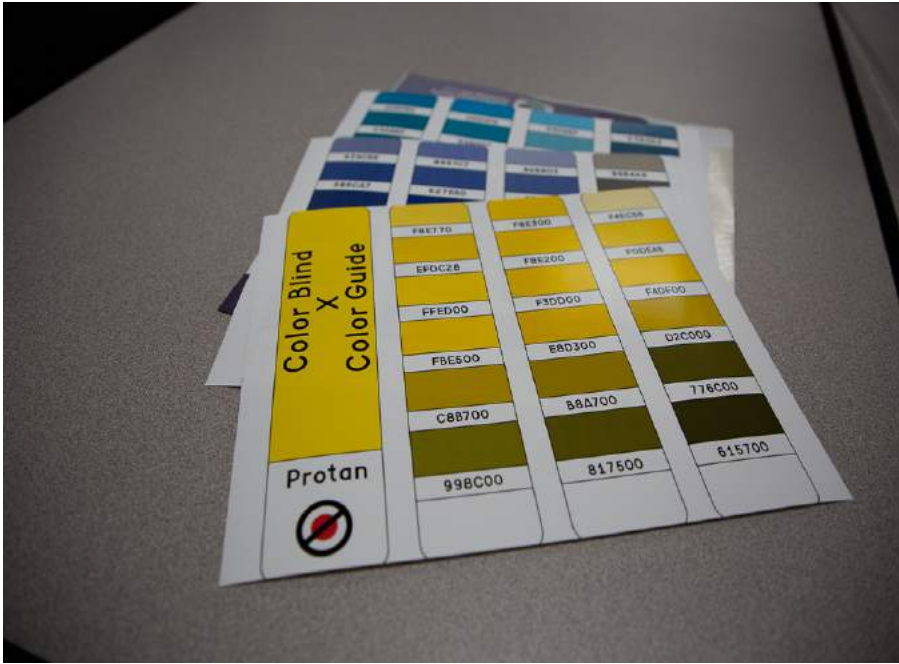
Each Book would have the name of the color deficiency, but a symbol would let the user know what color that particular deficiency has difficulty with.



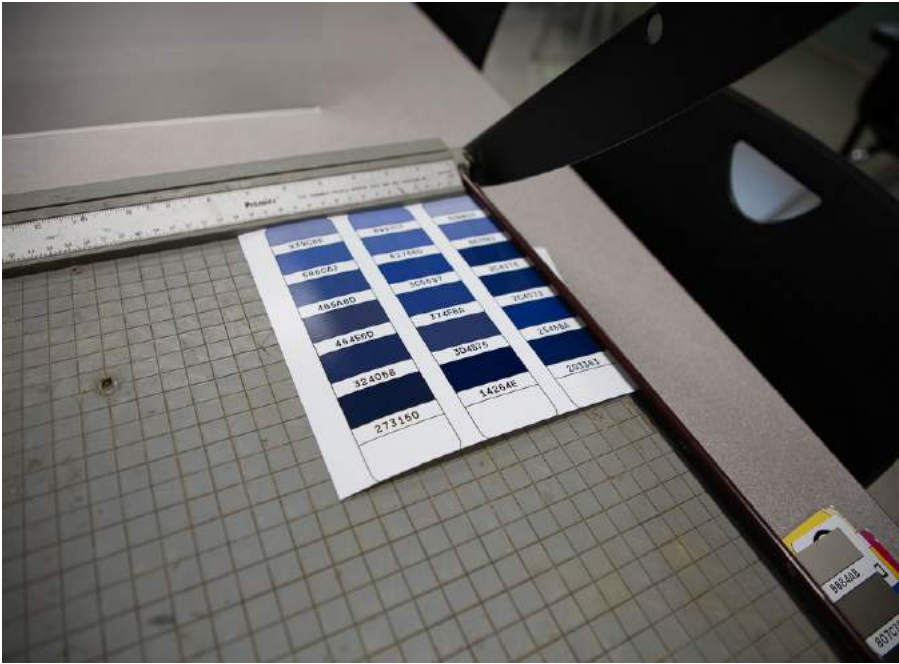
These books would only consist of a few color scales in both warm and cool colors perceived by the individual with this deficiency.



Each color would have the corresponding hex code below it for quick reference to the desired color.



As previously stated, my original desire was to have these created on plastic or some high-quality laminated cards-tock, which is still the ultimate desire to help with the product's life. However, due to the pandemic and my location, I was severely limited on options for the time allotted. As even the nearest Walmart is over an hour away from me, printing options were almost non-existent. So for the production of this deliverable, I decided to have it printed on matte photo paper. This is undoubtedly not the most ideal or durable option, but it will allow for high-quality and accurate colors. After having them printed, I began assembling them myself, which proved to be a bit more challenging than I had anticipated.

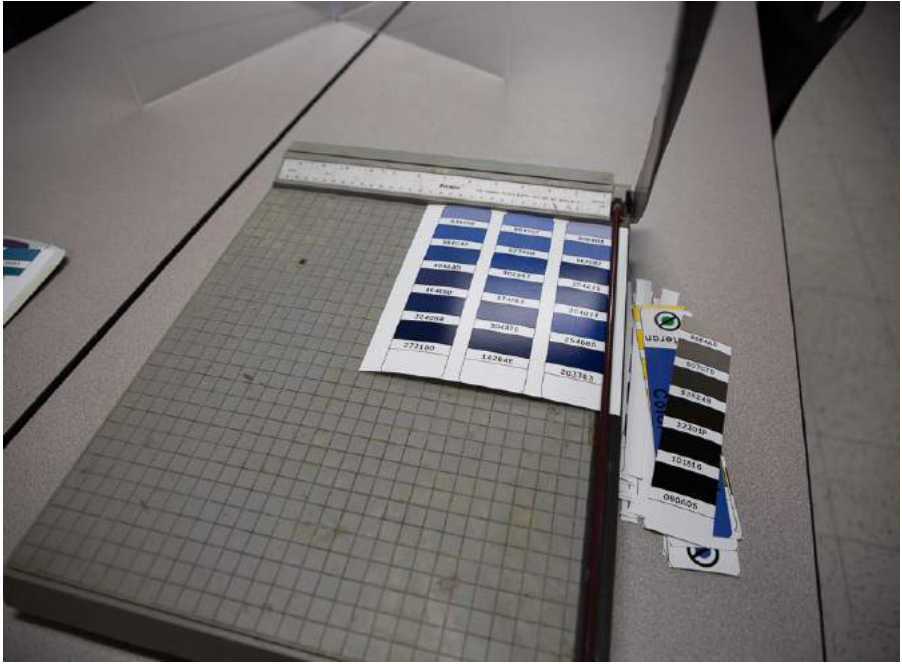


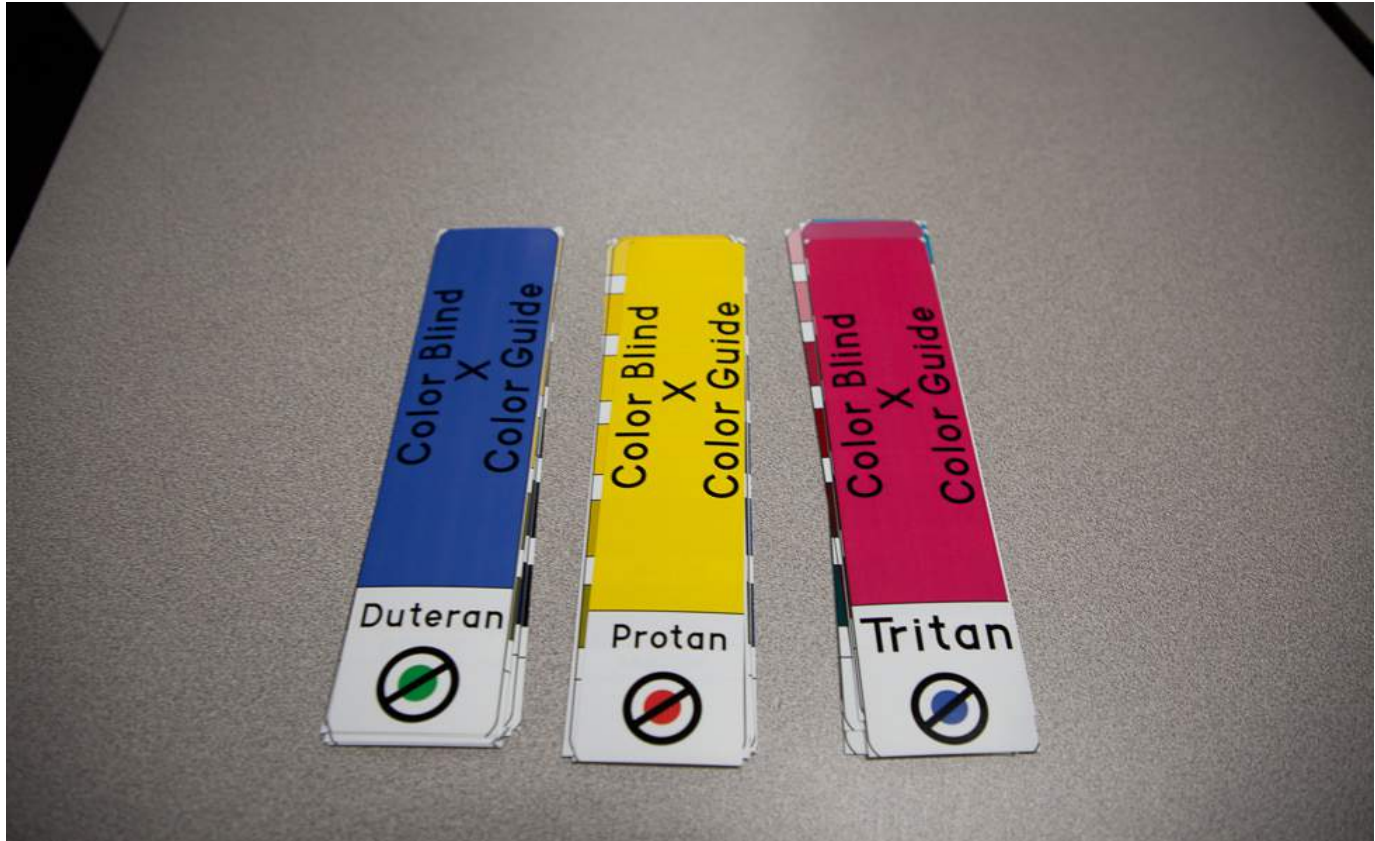
Once I had the prints separated, it was time to begin the cutting process; not having to cut the top or bottom was beneficial as it allowed for less error on my part, but it was also a huge time saver. At this point, I was cutting each section into its desired size and stacking them in order of where they would lay in the booklet. This would allow for a more painless and straightforward assembly process.

As you can see, the print went a little closer to the edge of the page than initially intended, but it allowed for less cutting, which fortunately also means a lower possibility for error. The colors and the pages turned out nice, and the size was exactly as I had intended it to be, so at this point, everything seemed to be going as planned.



The cutting process was relatively simple, however, once I had all of the pages cut, each section was narrow, and as I still had the corners to cut off, it proved to be a bit more challenging. The only option was to round off the corners with scissors, which, as small as each corner was, did not turn out as well or as consistent as desired. However, I did manage to get everything cut and ready to assemble.





Initially, I intended to make each book individual help keep them organized and used for each specific type, rather than having to sort through a series of protanopia colors when you are specifically looking for something intended for an individual with tritanopia. However, once I got ready for the assembly, I decided against that. The more books there are, the less likely an individual will take them with them if traveling or the more likely one is to get lost. This would have made an individual more likely to favor one particular book over another, which would defeat the overall intended purpose, which is to encourage designers to use this information to create more inclusive designs for all, not just one type of CVD. So, at this point, I decided to create one comprehensive book combining all three color deficiency types.

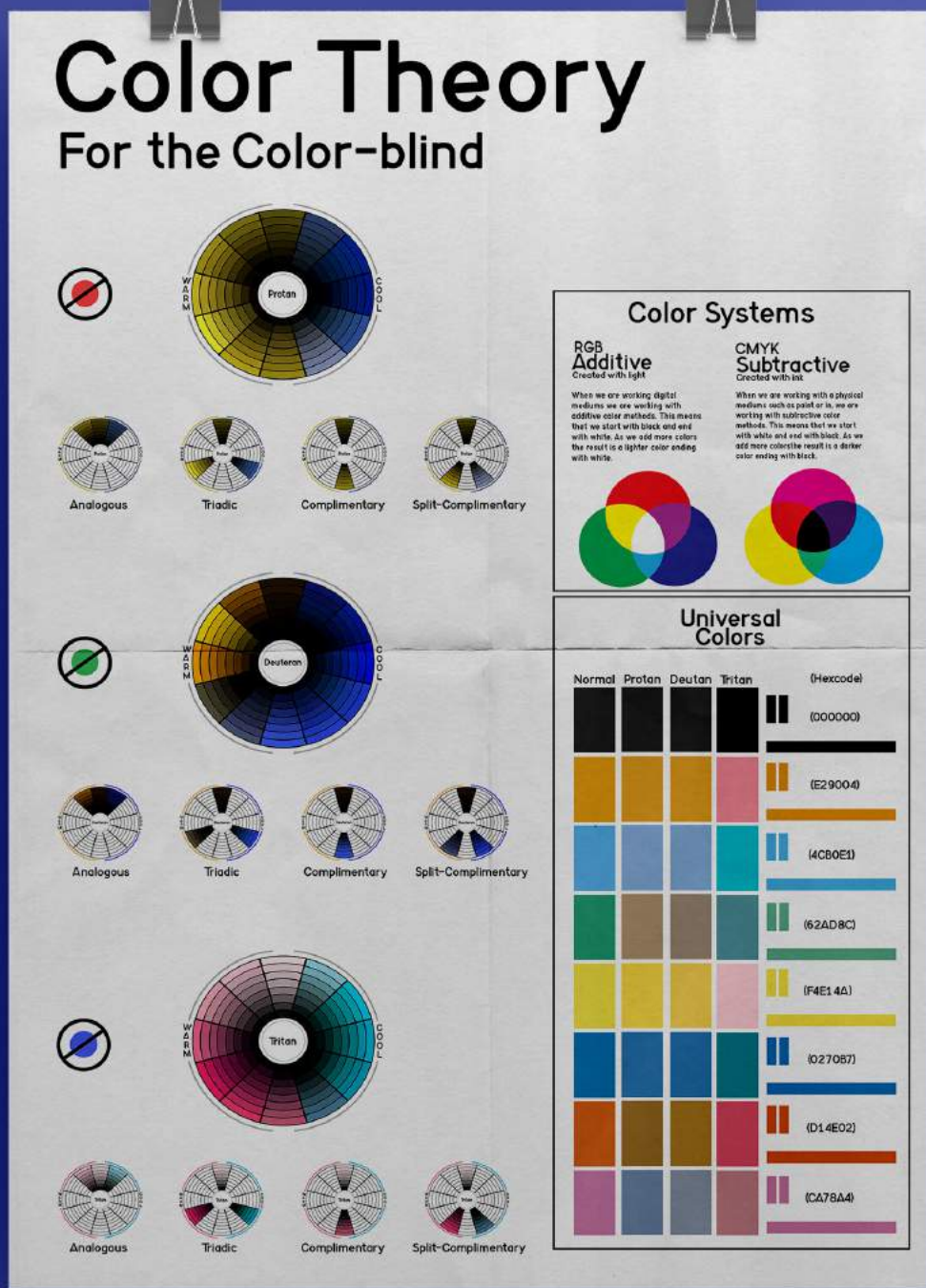


Here we have all three books combined and fully developed.

Here is an example of the book hanging on a wall in a nearby workspace.

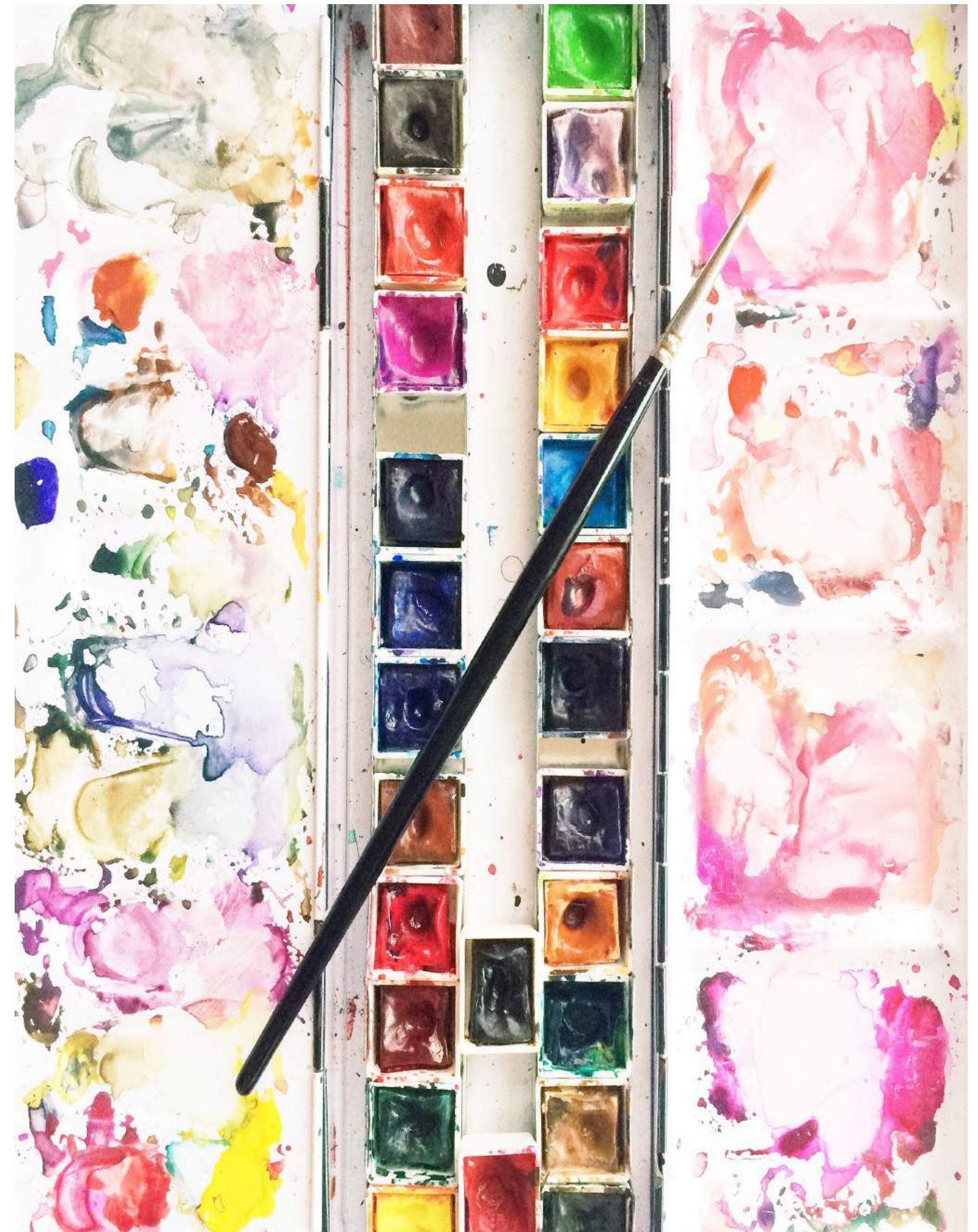


The Poster Design



Color Theory for the Color-Blind

The poster idea was the first and primary deliverable I had in mind. When I first started getting into photography, I got a poster that had all kinds of rules and principles of theory that I used for years until it was all seared into my brain. This poster had a ton of useful information like how and when to make adjustments between aperture, ISO, and shutter speed. In an age where the internet was not in every household and smartphones weren't even an idea, knowledge came from physical materials like posters and books. That made this informative poster the single most valuable tool in my self-education of photography. It was so great because it was a condensed one-stop-shop of all of the necessary information that I needed to progress in my knowledge and understanding of photography's essential aspects. This gave me the idea of applying the same concept to color-blind. Color theory is perhaps one of the most important aspects of graphic design as a whole, but when you consider its importance with those who suffer from color vision deficiencies, the importance goes up significantly. With this in mind, it was clear how much of an impact this could have. So I decided to design and develop a poster that would cover certain aspects that would allow the user to have that same one-stop access to some of the most essential color theory concepts but applied to the color-blind. In doing so, it will hopefully add to the designer's desire to create more inclusive designs.

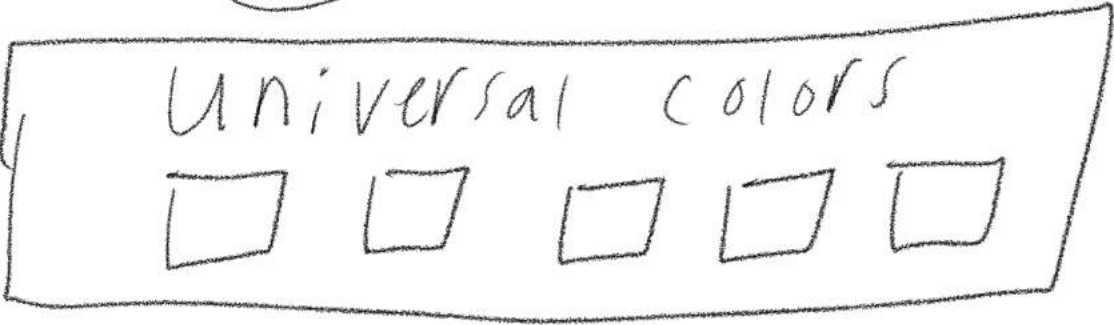
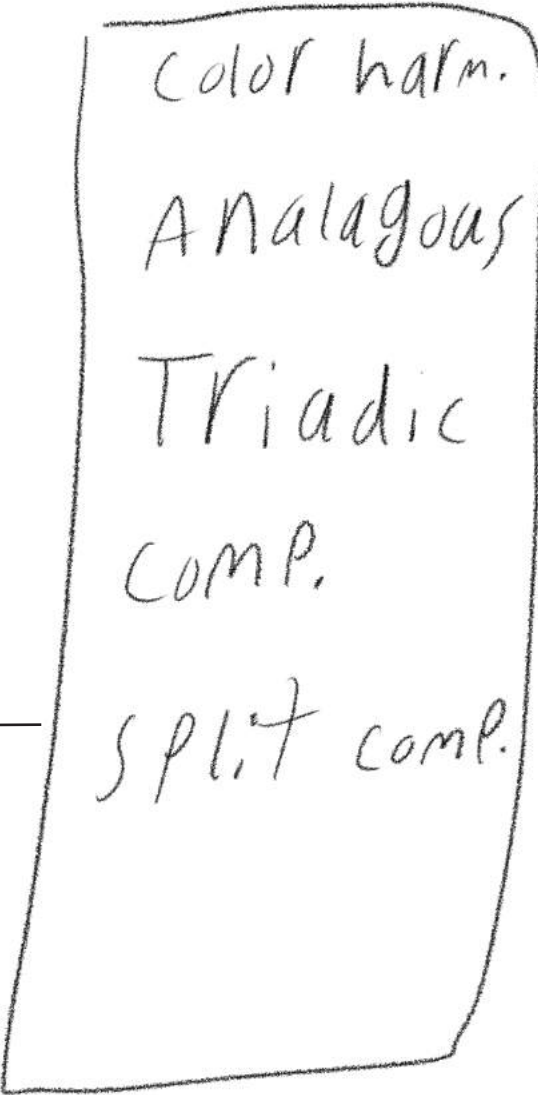
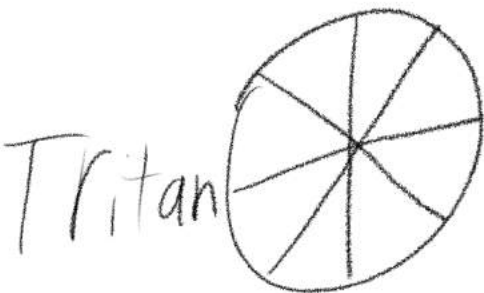
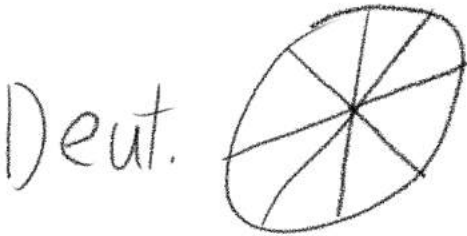


The poster's initial design had color wheels as you would expect on any color theory designs; however, instead of your typical color wheel, there would be three color wheels, each one based on a specific type of color vision deficiency. This would allow the designer to see the color wheel translated into acceptable colors for the corresponding

Another vital aspect of color theory is understanding the different color harmonies. This is crucial to the design process as it helps the designer to know what colors to select when thinking about their design. In the original concept, this section of the poster would showcase the color harmonies.

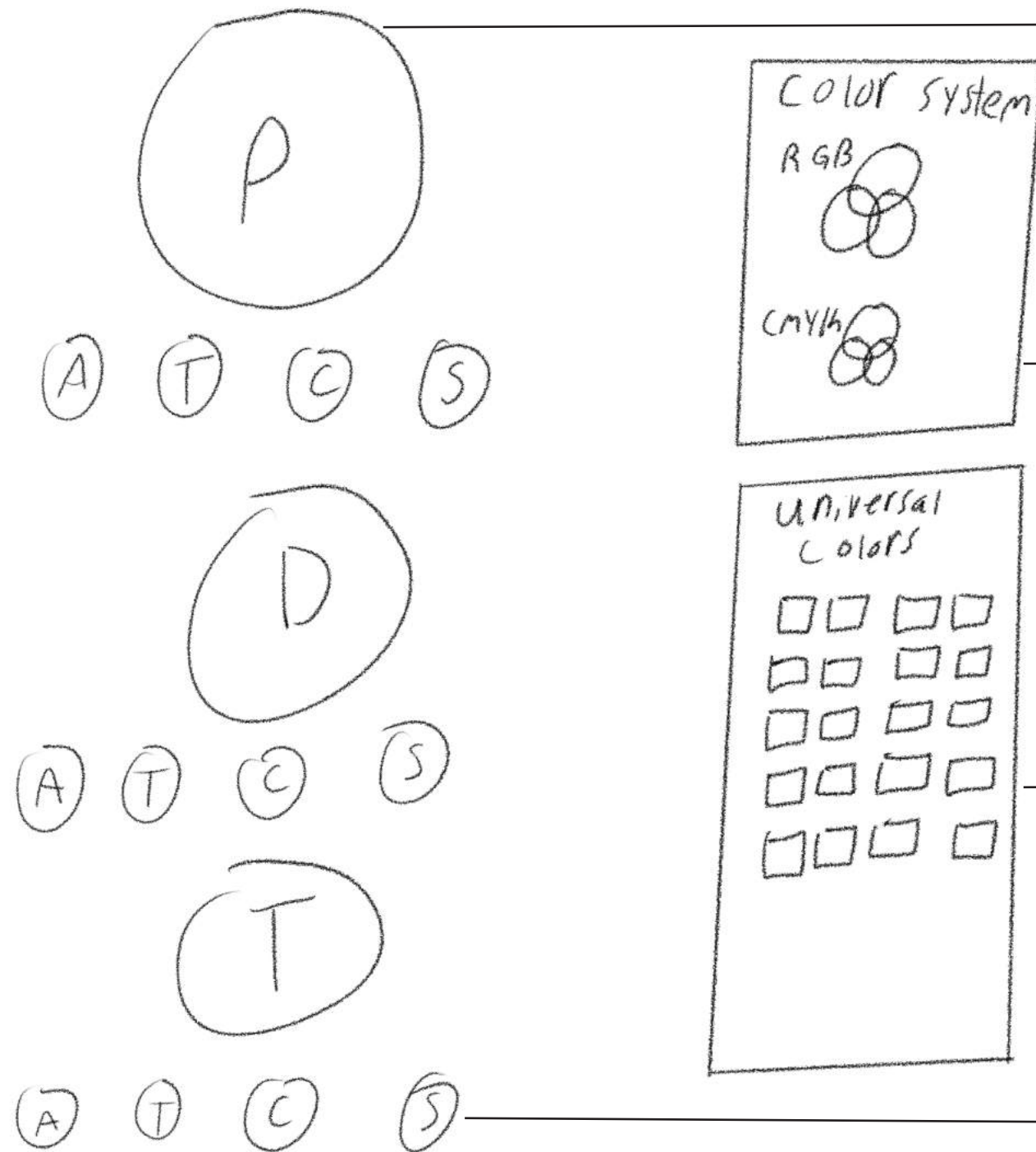
One of the more challenging aspects of understanding color theory with the colorblind in mind is knowing how to utilize it on a universal aspect. The overall objective is to create material that could be used to help the designer create more inclusive designs. Creating a section that includes universal colors that can be utilized with all of the color deficiencies.

Deliverable 1 - Poster



Color Theory

For the color blind



The second iteration of the poster design changed a few aspects to help enhance the amount of incorporated information while also streamlining what already existed. This portion of the newer design is the only portion that did not change. Each type of color deficiency would have a corresponding color wheel specific to that corresponding deficiency's perceivable colors.

This section would showcase color systems, which is a new aspect of the poster design. While this portion does not have any specific importance to color-blindness, it is an essential aspect of color theory. It would briefly give the user an understanding of the difference between RGB and CMYK.

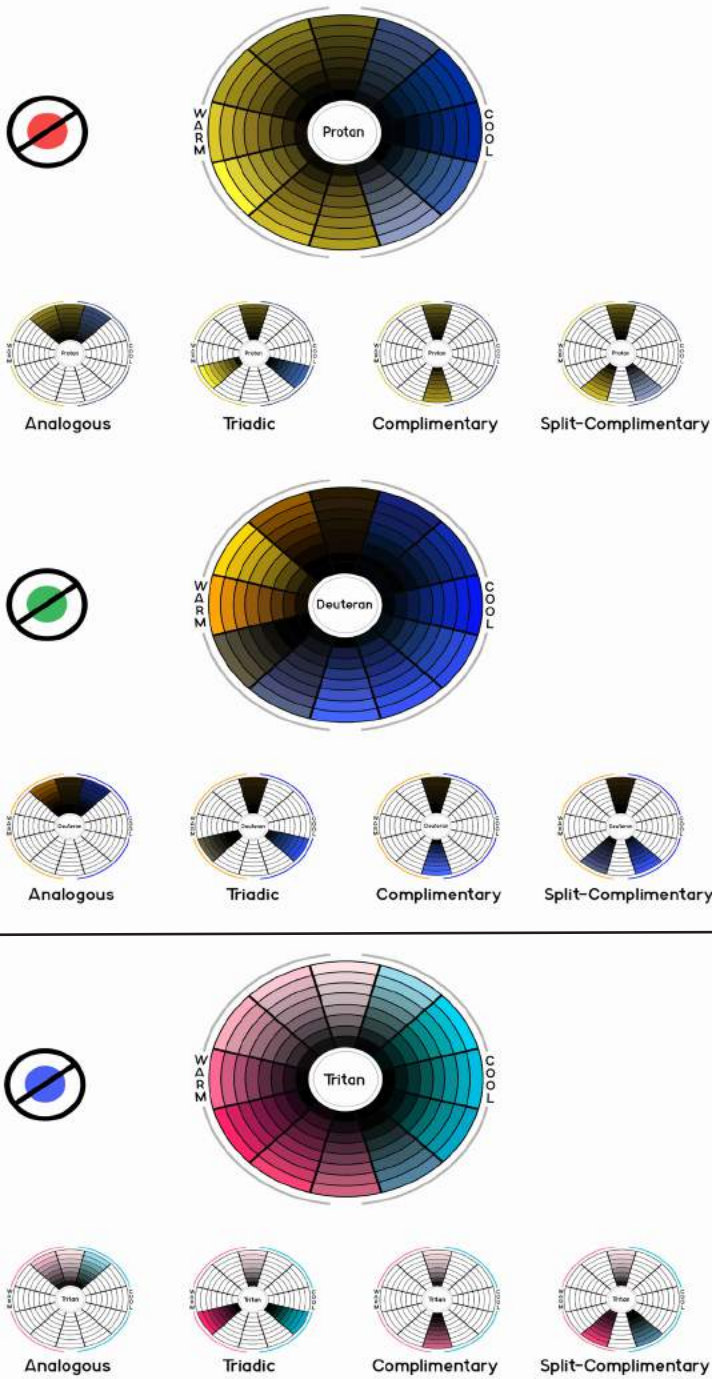
In this iteration of the poster, the portion of the universal color is a bit larger to showcase colors for each specific color deficiency and universal colors that are applicable more universally.

Each of the color wheels would also include the color harmonies for each specific color vision deficiency. This would allow the designer to see the color harmonies applied to the specific CVD more easily, making the overall design more efficient.

The first digital iteration of this design remained pretty close to the sketch layout. The most considerable difference was the addition of a visual aspect to each color wheel to determine what color that deficiency struggles with. This was important as most people will not know what each of the types is simply from the name.

Color Theory

For the Color-blind



The second change to the first digital version was the addition of actual color and hex code to the universal colors. For this section, I decided to have a series of colors in normal vision and show how that specific color is perceived by each specific deficiency. On the outside is the most universal colors for each visual impairment.

Color Systems

CMYK Subtractive
Created with ink

When we are working with a physical medium such as paint or ink, we are working with subtractive color methods. This means that we start with white and end with black. As we add more colors the result is a darker color ending with black.



RGB Additive
Created with light

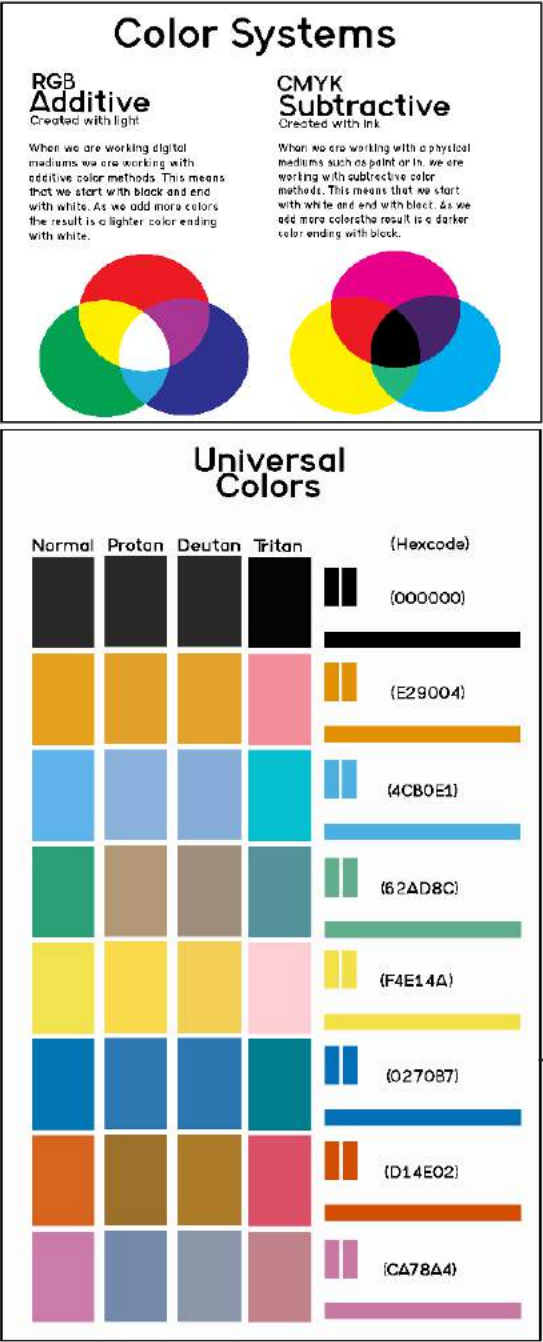
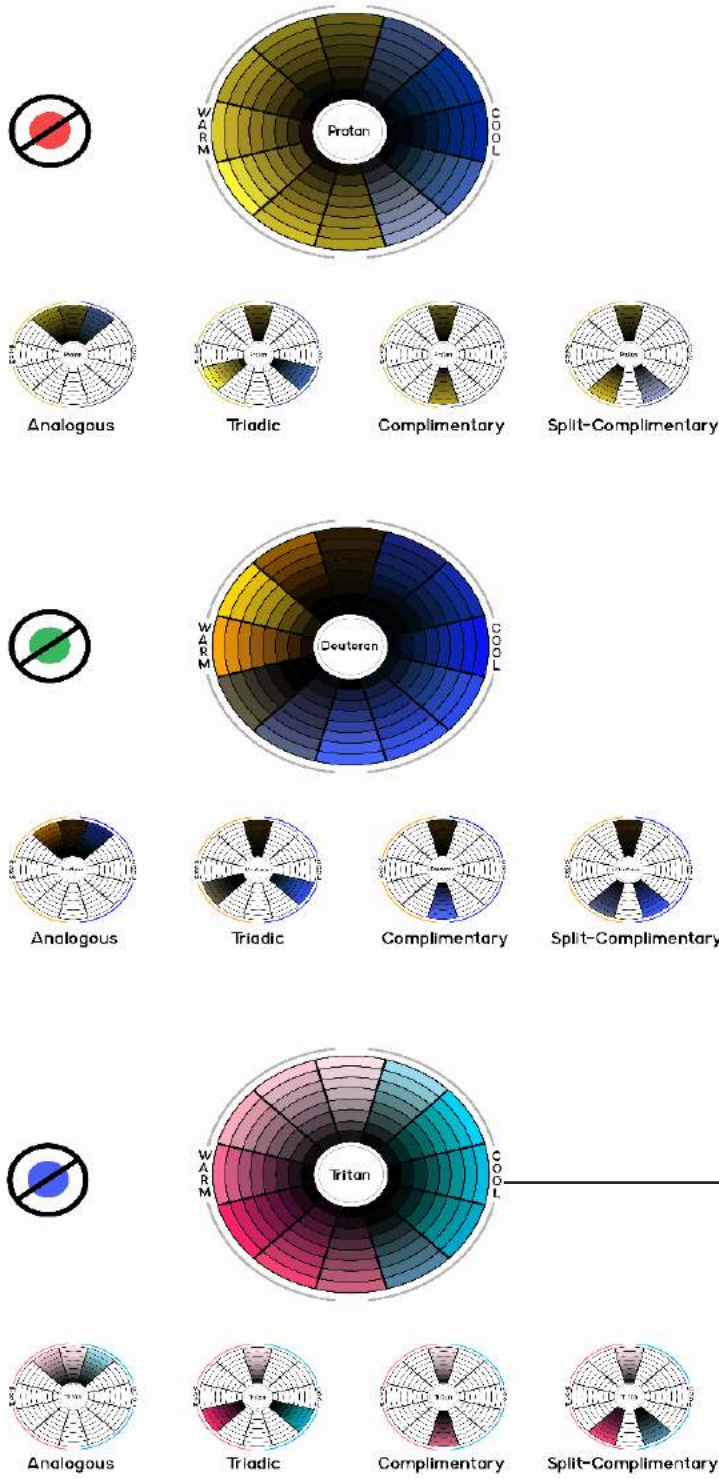
When we are working with digital mediums, we are working with additive color methods. This means that we start with black and end with white. As we add more colors the result is a lighter color ending with white.



Universal Colors				(Hexcode)
Normal	Protan	Deutan	Tritan	(000000)
				(E29004)
				(4CB0E1)
				(62AD8C)
				(F4E14A)
				(0270B7)
				(D14E02)
				(CA78A4)

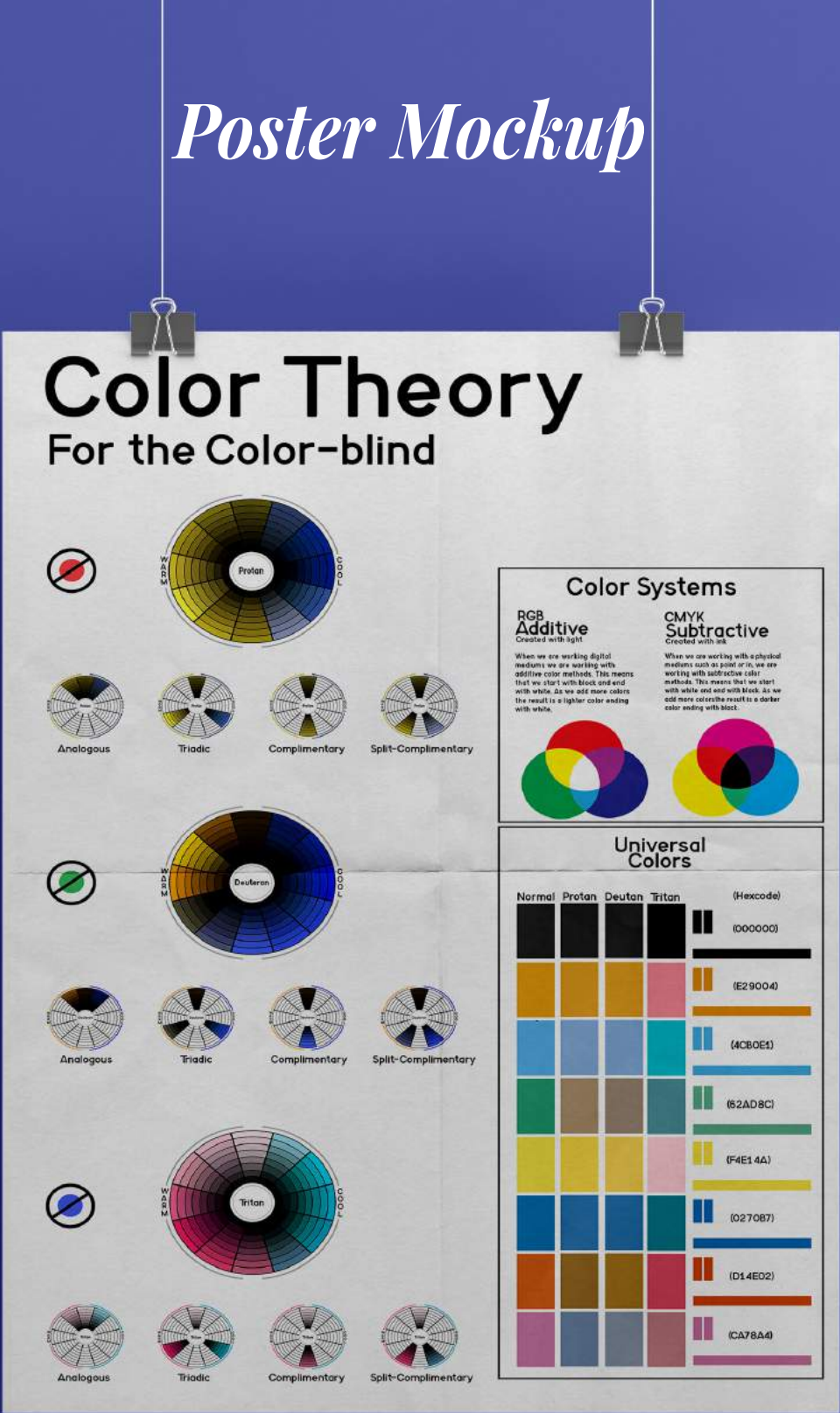
Color Theory

For the Color-blind



With the second digital iteration of the poster design, there was not much change. It was more about refinement than making significant changes as the information works, and the majority of the design is functional. The first change was to take the previously stacked color systems and place them side by side, making the box more uniformed with the universal color section. There was also a small leading issue that was corrected within the text.

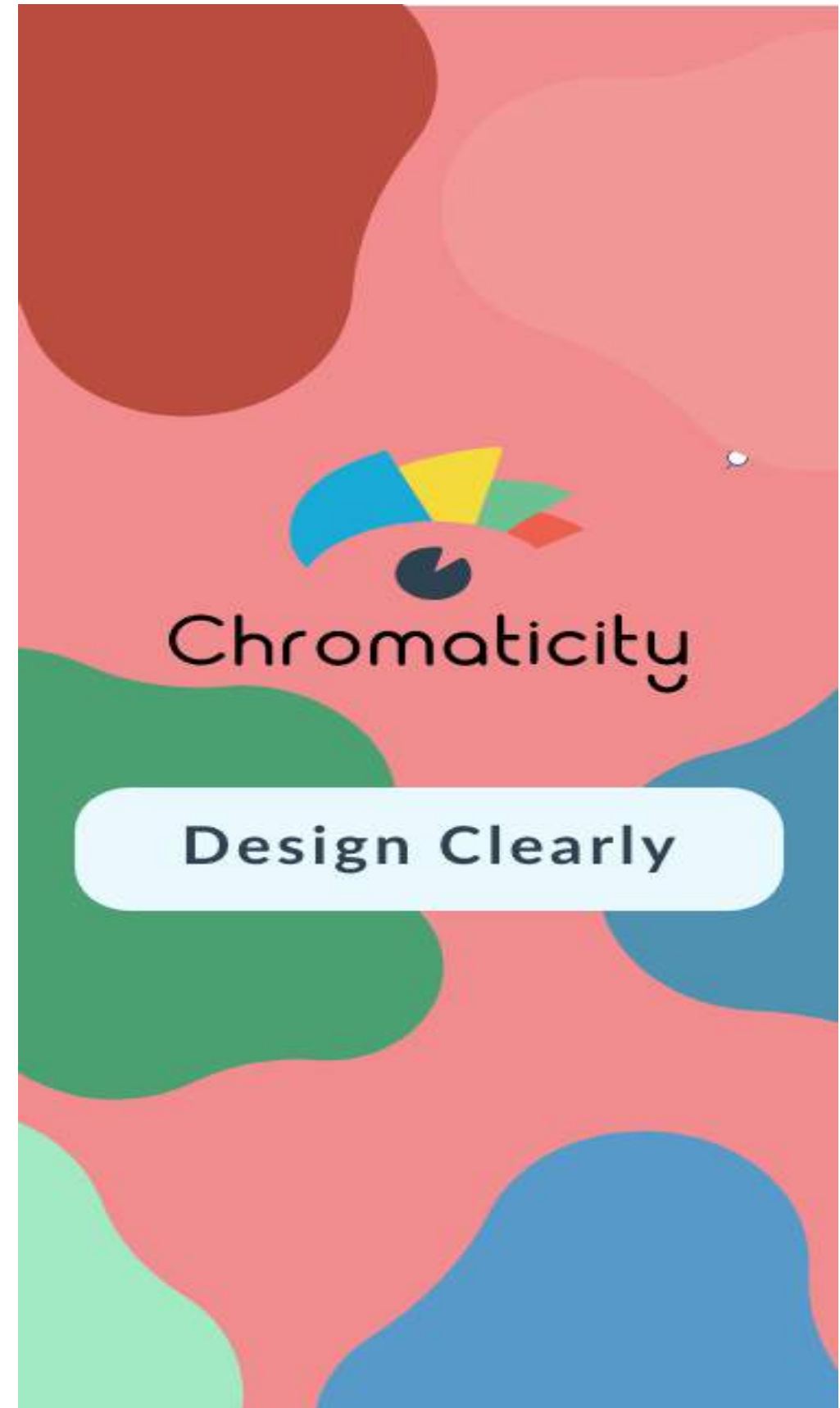
The second change was to minimize the color wheel sections slightly to allow for more separation of each specific type to allow for clarity and better readability. Again this was not a significant change, but hopefully, it will enhance the overall layout of the design.



Developing an App

Once I had completed my poster design and the Pantone style book, I thought I would feel a sense of completion and gratification; however, it was the complete opposite. Upon holding the finished products in my hand, I was left with a sense of remorse and borderline guilt. I had completed my proposed products, but I still felt like I had not accomplished anything. While I stand by the work I put into those designs, I could not help but feel as if I had taken on this significant project only to reach then end and take the easy way out. The two deliverables did not match up with the level of research and work I had put into understanding these visual impairments, and my solutions seemed incomplete as a result. This sent me into full panic mode as I had no idea what I could do or how I could execute it. So I began to rethink everything; I went back to the thesis handbook and looked at what was expected of me with this project, hoping that this would provide me with some form of restitution. At this moment, I read where the goal of this project was to highlight and adequately represent our time at Liberty University. At this point, I began to go over old project files and contemplate all of the classes I took and the knowledge I gained thus far. Through the entirety of my short but in-depth time at Liberty, I always let one thing be my guiding factor, whatever I did, it had to be outside of my comfort zone. This reverberated through my brain like an alarm. Every class I had taken to every project I worked on was me stepping out of my comfort zone and trying to tackle something I would have previously thought impossible for me. Even my thesis topic was something that terrified me, but I knew that it was something that was of the utmost importance. This helped me become a better designer, but it helped me better understand the different perspectives that I believe have helped me grow as a person. At this point, I knew why I was so disappointed with my visual solutions; they were safe and were not a representation of my experience through this academic journey. Furthermore, I believe that because I took a safer and more straightforward route to my visual solution, I was not doing the service that the people I had previously worked so hard for deserved. This is information that designers and the visually impaired could be greatly impacted by, and I was not doing everything to bring my work to its fullest potential, which let me as a designer down, but could negatively impact those who could use this work.

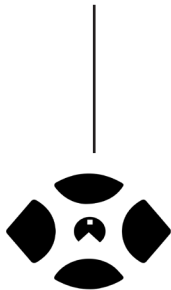
Upon sharing this sentiment with my best friend, who is a designer for a creative company in Tennessee, he mentioned that it was too bad I could not develop an app because there is only one other app out there that even comes close to assisting that understand color-blindness and that it would be something he could use daily. All at once, it all seemed too obvious. I had not even considered the incorporation of a digital aspect to my visual solution. It seems as if every discussion board post and every essay I wrote at Liberty brought up the idea of the importance of transitioning into an increasingly digital world. Nevertheless, I had completely neglected this aspect when it mattered most. As far as the format goes, developing a smartphone application was the perfect solution as it is incredibly practical, would be far more accessible by designers no matter where they are, and perhaps most important, it is great outside of my comfort zone. There is was the ultimate visual solution to my problem. As terrifying as this project was, I knew that it was exactly what I was missing, more than that though it was exactly what anyone who might benefit from my work deserves.



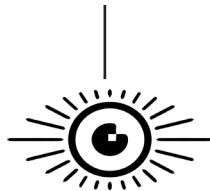
Logo Development

Since this visual solution is the most inspired and, to some extent, the real culmination of all of my research and work, it has resulted in significantly more in-depth preparation for this solution. The first aspect I knew that I needed to focus on was the branding; after all, any product's marketability comes from the branding and packaging's visual aspects. I knew that I wanted to design something involving color and eyes, nothing too abstract. Initially, I began trying to sketch out some designs; however, this is not exactly the strongest aspect of my design game, as you can see to the right. However, this is an integral part of the process; if nothing else, this would help me better understand what I needed to do or where I needed to go next.

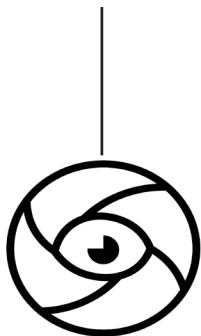
With this design, I wanted to have an eye shape with separation for multiple colors.



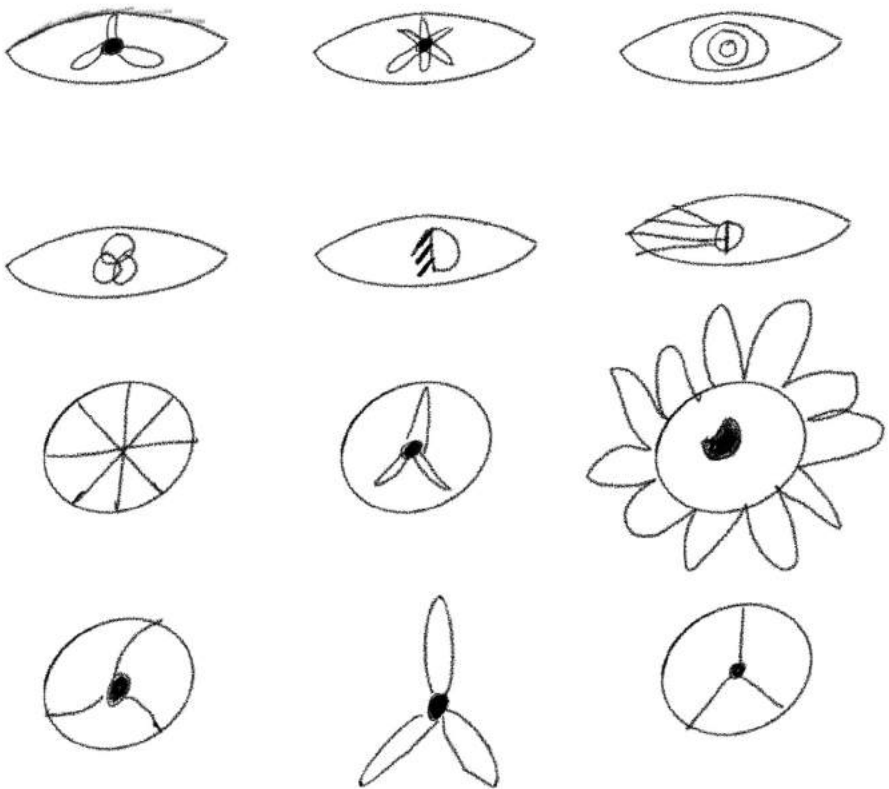
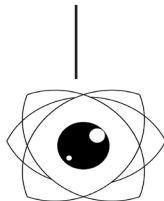
This design, I focused on the idea of light with a hint of digital as well in the iris.



With this design, I was trying to play with the aperture of a camera lens.



With this design, I made a basic eye shape and spiraled it in a flower-like shape.



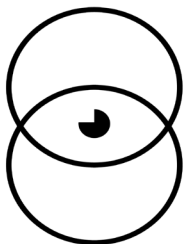
With the first of the digital iterations, you can see no comparison to the drawings. It is a lot easier to make something that looks like an eye in Illustrator than hand drawing it. With these iterations, I wanted to focus more on the variations than similar designs, hoping that this would help me see a more precise direction.



With this design, I wanted to play around with the all-seeing eye.



This was a variation of the other aperture design, but with less of a Google feel.

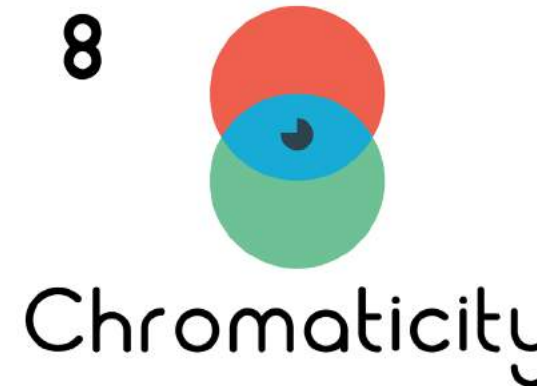


This one was designed with color in mind; I wanted two overlapping colors to make an eye shape.

Adding Color

Forma
Regular

ABCDEFGHIJKLM
NOPQRSTUVWXYZ
abcdefghijklm
nopqrstuvwxyz
1234567890



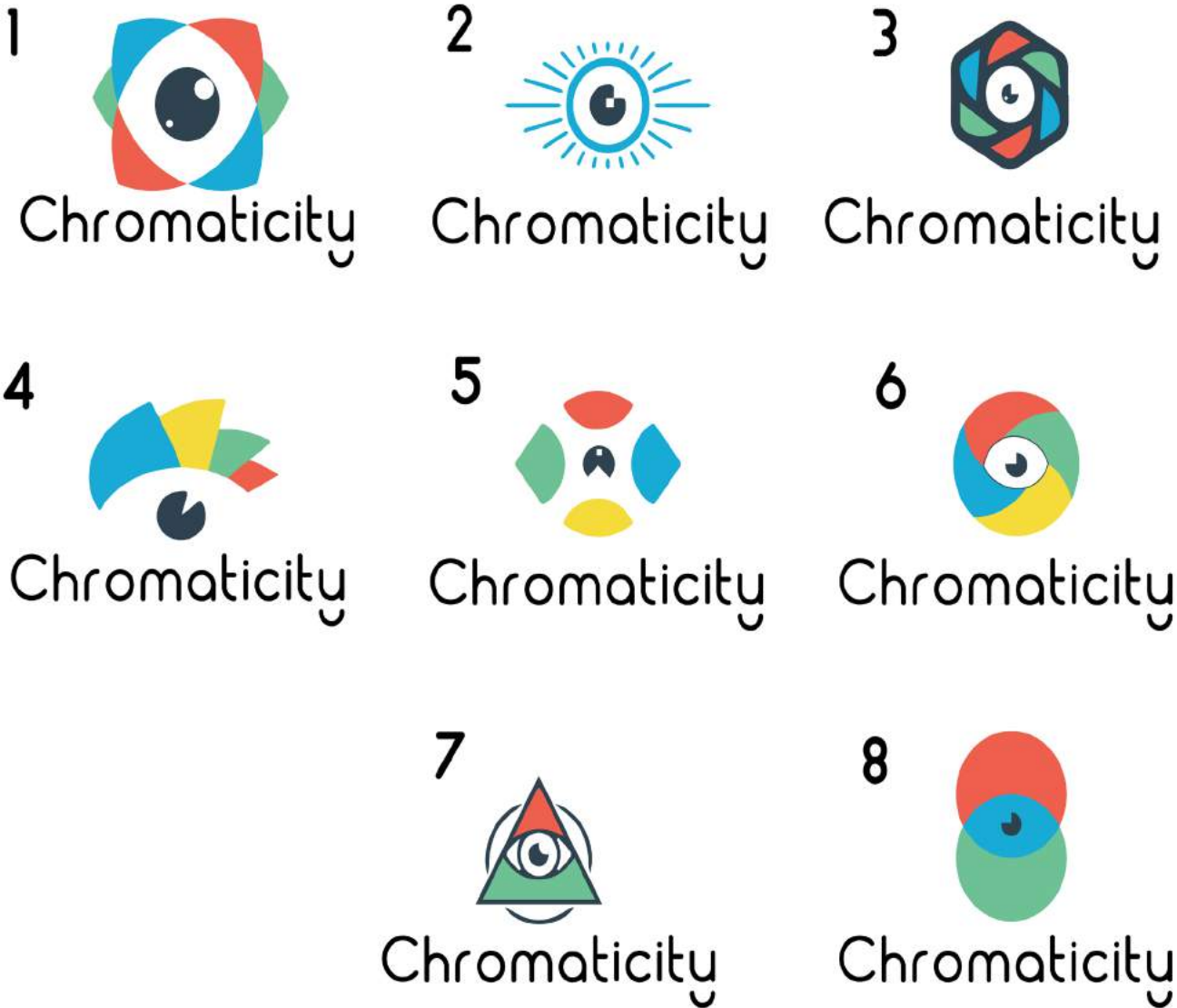
As I began to work through developing the digital iterations and thinking through names for the app, I tried to think about what I wanted to convey. Since the premise is to help designers think about how we see things and help re-train the way we use color in our designs. With that in mind, there needed to be two apparent aspects, eyes, and colors. As for the colors, I knew I wanted to use primary colors as they are a typical representation of color in general. However, I also wanted to incorporate a green to play on the three leading color deficiencies. Since there are many dominating and contrasting colors in use, I wanted to use slightly muted colors to help color dominance and help with eye strain. With a navy blue for the text and strokes, I believe the colors balance quite well. As for the typeface, I knew I wanted to go with something more modern and almost futuristic to suggest that this was the future of graphic design, especially considering those with color vision deficiencies. During the typeface selection process, I played around with several striking typefaces. For a while, I thought I might go with Futura as it is perhaps one of the most versatile types in existence, not to mention it is specifically designed to be a modern yet timeless type. However, as it is an older and more familiar typeface, I decided to go with something else. Ultimately, I came across Forma, an absolutely stunning sans-serif typeface that certainly has a futuristic feel, but the rounded, almost bubble-Esq letters also give it a fun and relatable feel that maintains reliable readability. When thinking about what to name the app, I wanted to either go with something with sight or color.

Since the main idea behind the log itself was centered around some form of an eye, I decided to balance everything out by giving it a name centered around color. Surprisingly enough, there are not many chroma options that aren't already taken. Finally, I came across chromaticity. By definition, chromaticity is "The quality of color, independent of luminance." While I am aware that luminance plays a significant part in the perception of color, the verbiage of quality of color is something that struck me, especially when ultimately, this whole premise is to create something that will ultimately enhance the use of color for all people and therefore increasing the quality of our designs. For the logo design, I feel like this was the absolute perfect typeface. As far as what logo I decided to go with, As much as I originally intended to stay away from abstract designs, they apparently kept calling me back. While the "eye" concept is a bit more literal in some, it is incorporated into each design. I was most drawn to number four on the list as the eye is formed out of negative space, and the colors form an eyelid of sorts. In my opinion, it was the stronger of the set. However, this is still an area that I would like to continue developing to bring out the most effective design for this project. Number six ended up looking like the Google Chrome logo, and a friend pointed out that number five is exceptionally close to the Kroger Gas logo, which was interesting since the last time I have seen a Kroger was close to fifteen years ago. Numbers

one and three are also on the top of my list for possible logos, but as a decision needed to be made, I went with four as the use of negative space to me not only looks more visually appealing but could open up for some exciting logo animations, perhaps for states during prototyping and development. Once I had finalized the logo, chose the colors I needed, and selected a typeface I was truly excited about, I was ready to begin work on the application itself's structure. The next step was to think about flow and then the layout of the Chromaticity app.

Forma
Reugular

ABCDEFGHIJKLM
NOPQRSTUVWXYZ
abcdefghijklm
nopqrstuvwxyz
1234567890

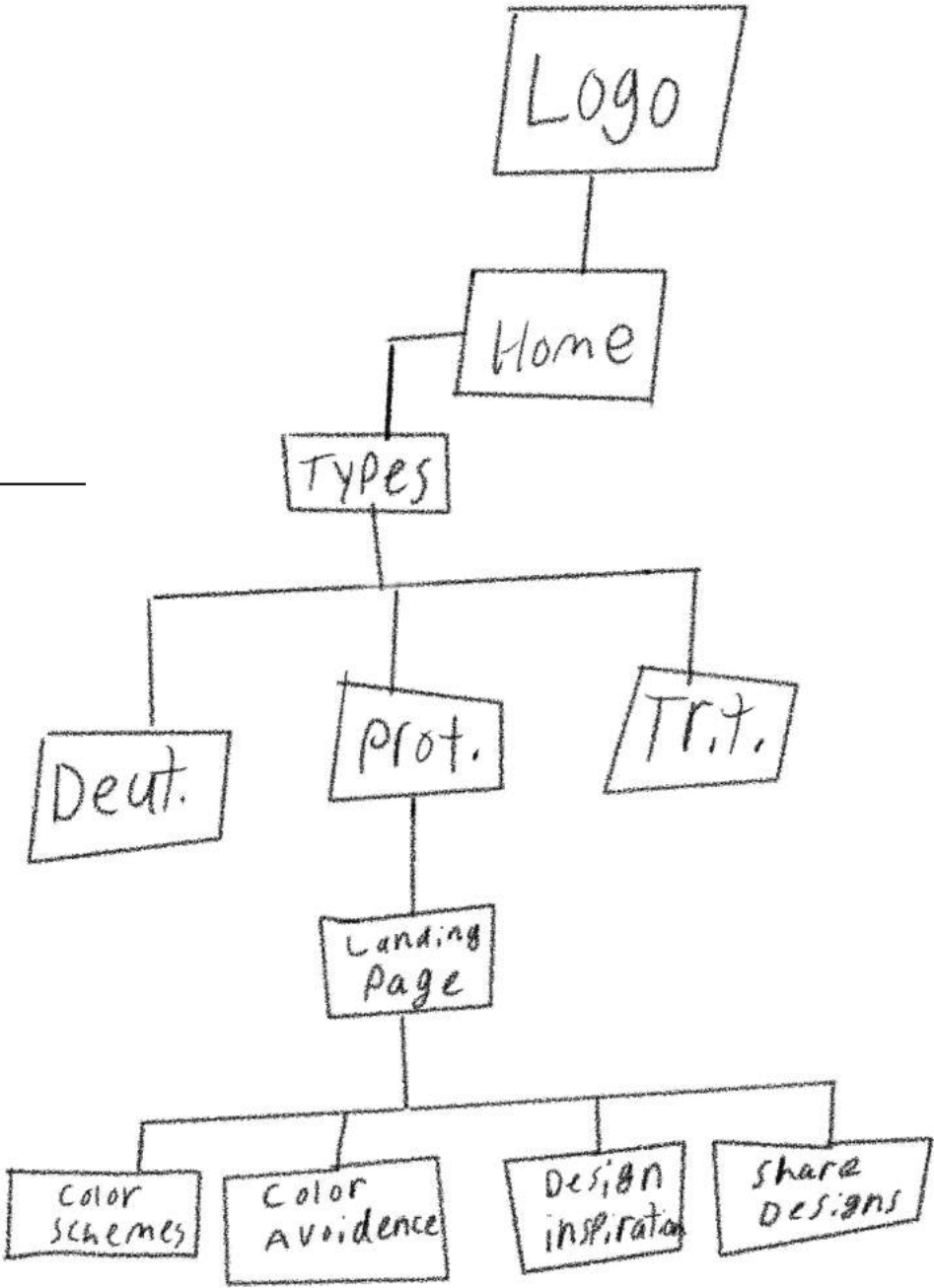


Functionality and Layout

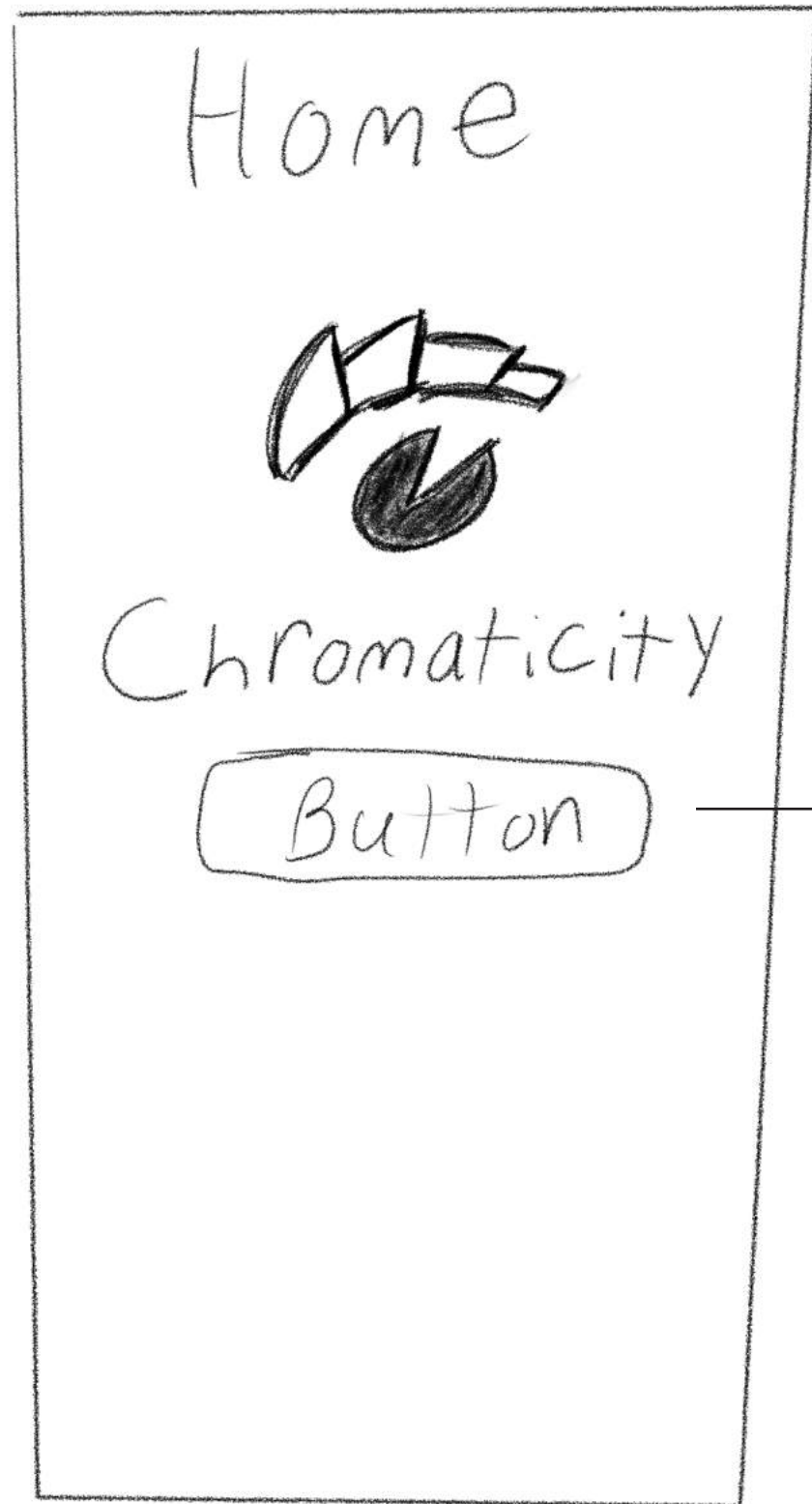
Now that the logo was developed, it was time to move on to the functionality. At this point, my mind was racing with ideas, and I was beginning to get much traction. The dangerous thing with that, though, is that one could go too far, adding in more and more thinking it would enhance the use of the application and, in doing so, would enhance the UX of the app. When I first began writing down ideas of what should be included, it did not take long to realize that I was initially making it way too complicated; a good UX should be simple, clean, and to the point. So I began making a flow chart. The first significant aspect needed to be covered the different CVD types: Deuteranopia, Protanopia, and Tritanopia.

The second significant aspect that I wanted to include in the app was four separate functions that I believe will be extremely useful to designers. The ultimate goal here is to help educate designers about a visual impairment that they may not understand, which is the first half of the app. The second and to me, almost equally as necessary, is to help designers create more inclusive designs. This second section will consist of four buttons, each of which is paired to the specific color deficiency you are looking at. The four buttons would include a section with color palettes useful to use with that specific impairment. The next part would be colors that should be avoided and why. The third button would be designed to use color patterns that are easily distinguished by that specific type (like a color-blind friendly Dribbble). The last button would be a way to upload and share your designs so that you could help inspire others, which is the point of it all, to inspire.

APP flow



APP



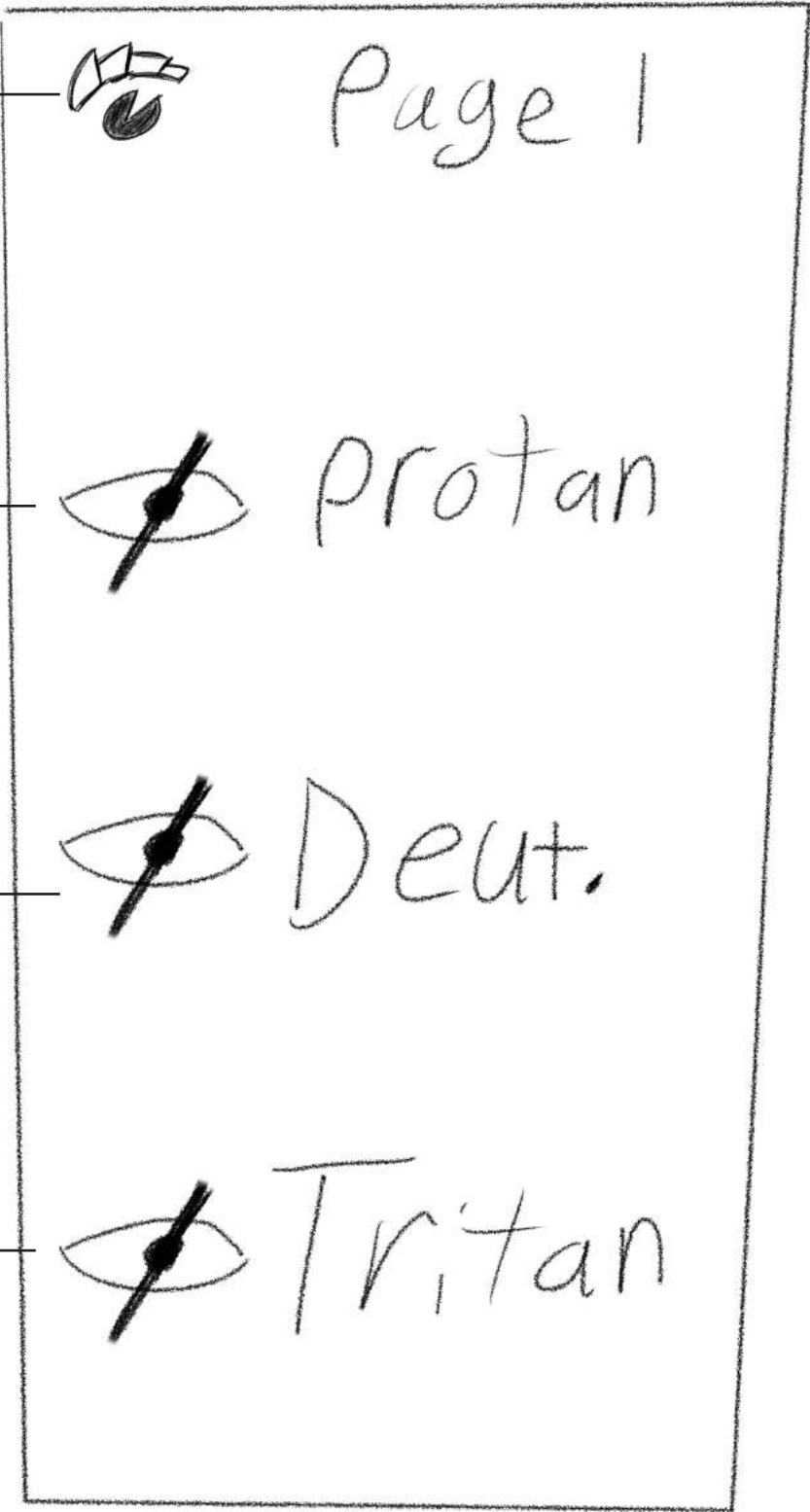
The opening screen of the application is designed to be rather simplistic. It would merely reveal the logo and a button that would let the user activate or go to the first page of the application. I did contemplate not having a button for access, but as the application will eventually have account-specific information (submitting unique designs), this will eventually transition to a login page.

The app's logo transitions to the top corner and will become a home or return button so the user could always quickly get back to this page no matter where they are in the application. It is crucial to have a home button as this will always help the user know that they will not get lost in the app.

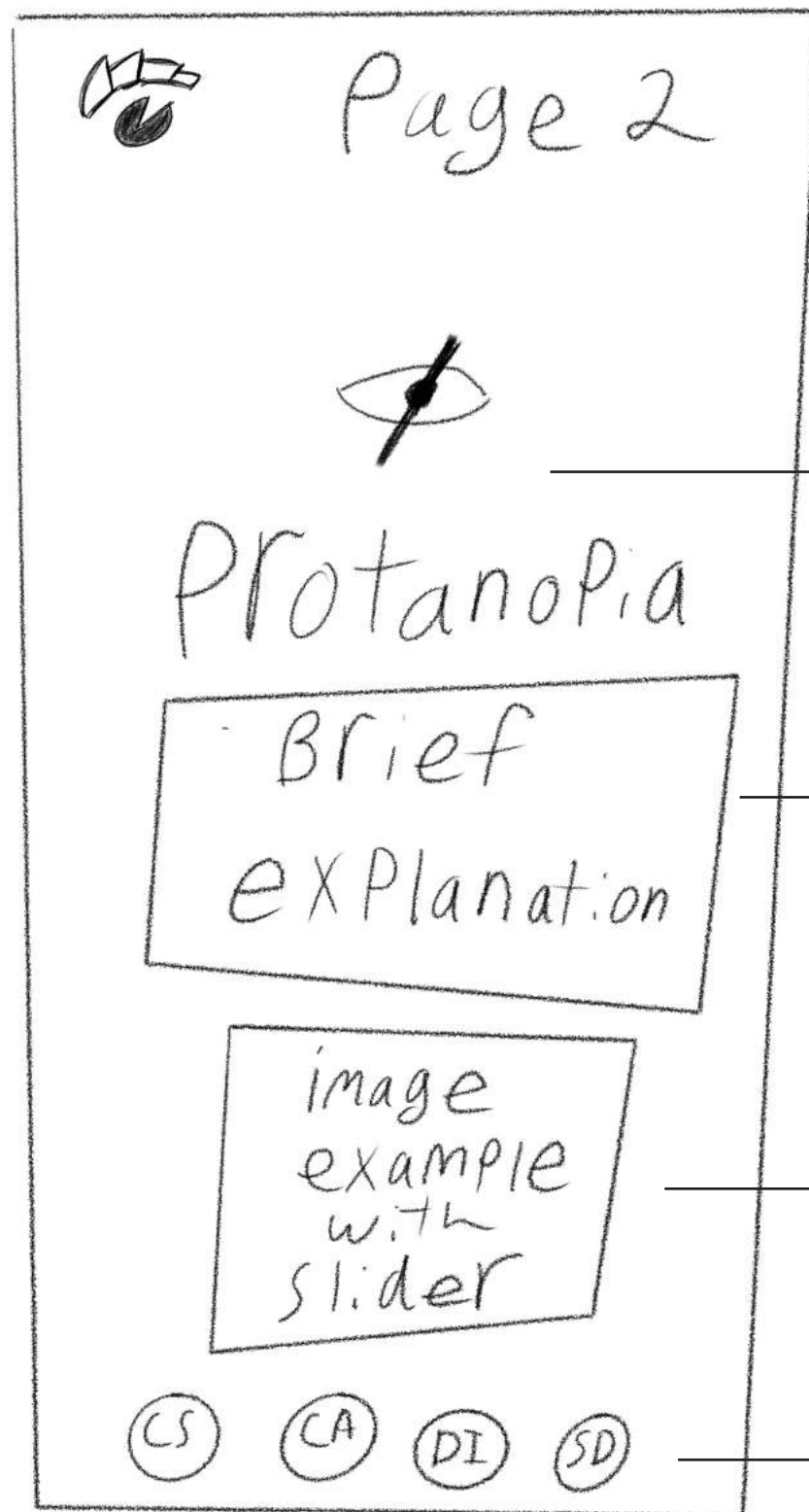
The iris of the eyes will directly correlate to that specific color vision deficiency to give the user a visual aspect that this is a color they cannot see. The idea behind this is to help the user know that even if they do not know the type of impairment, they will know they cannot see red and still be able to navigate the app.

This page, as previously stated, will be the return scree for the home button. It will allow the user to quickly return to the screen to choose a different CVD and look a the information pertinent to that should they so choose.

APP



APP



The eye and name transitions into almost a title for the page, allowing the user to associate all of the information on this page with the name of the deficiency and what color this type cannot distinguish between.

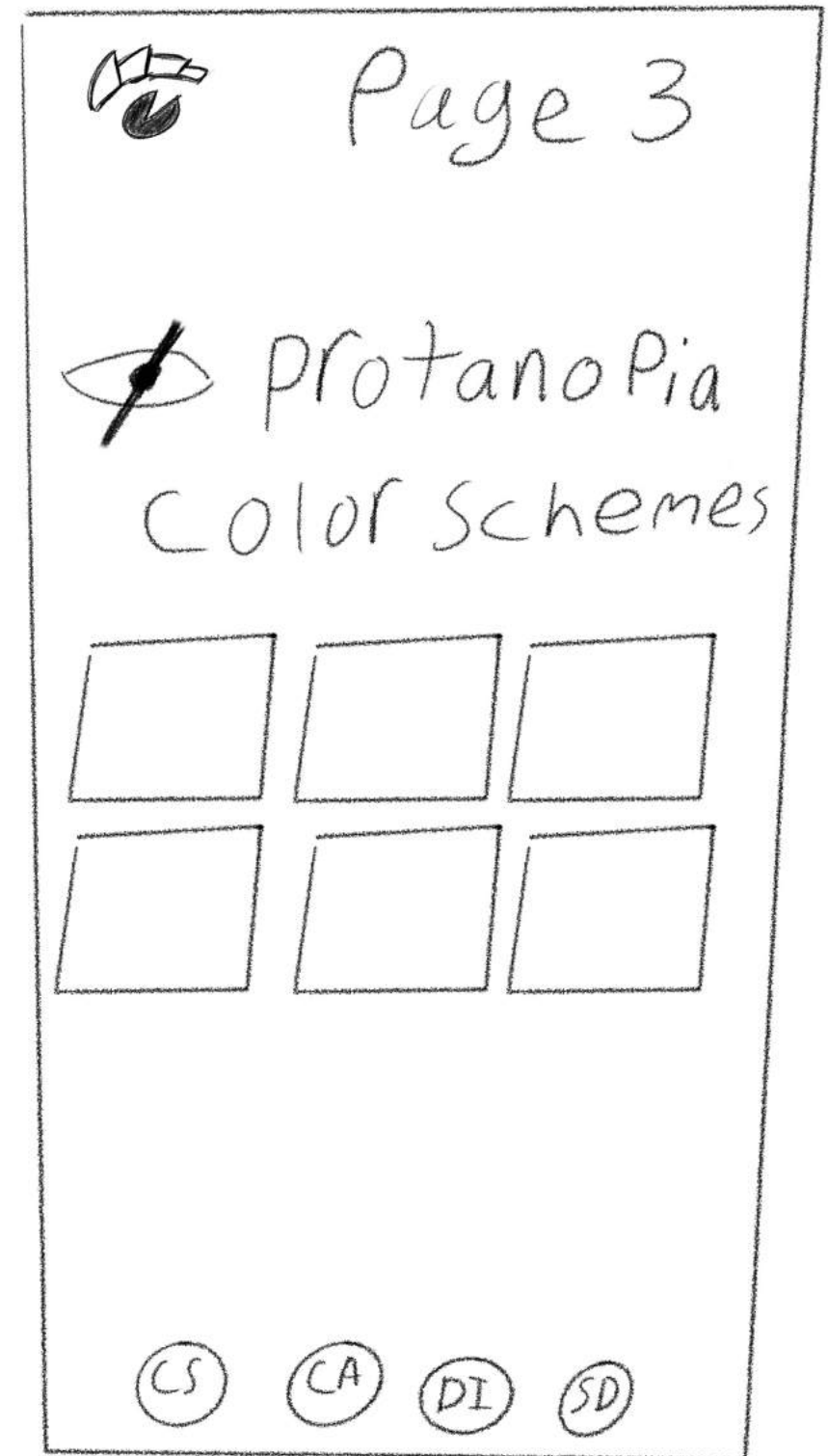
As previously stated, a significant purpose of this application is to help educate designers about this disability; in this section, there is a brief explanation of the specific deficiency.

This section is perhaps the part I was most excited about. As designers, we are generally more visual learners, as for myself, when I can see something being applied, it makes it a lot easier to process. So this is a static image that has a slider reveal so the individual can see the picture in normal vision and how an individual with this deficiency would see it.

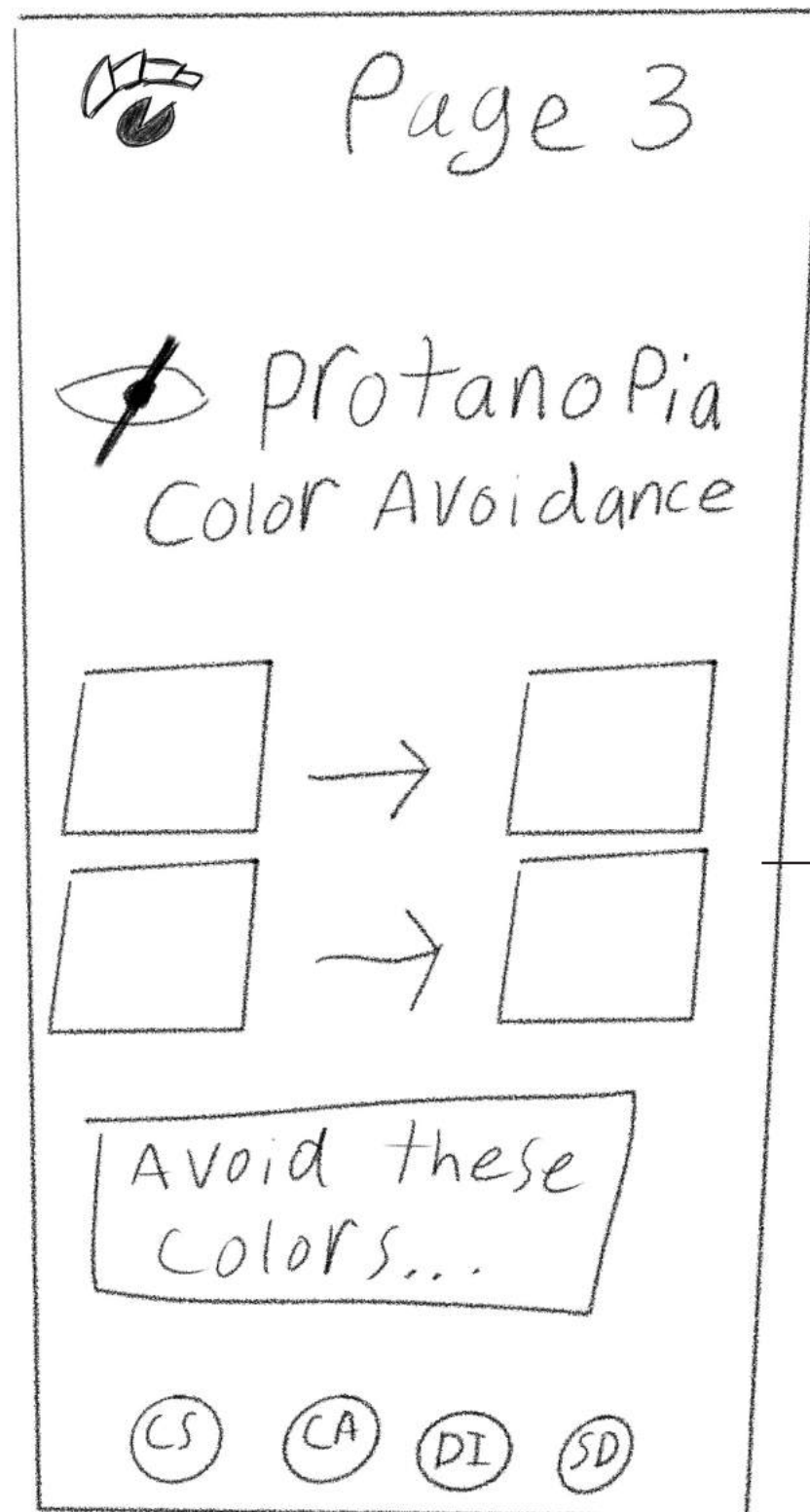
Here we have the four buttons that will take the user to the different components of this application. This meant to help simplify the application as well as provide meaningful information as it is needed.

This section is all about colors that are good to use for each specific deficiency. As a designer, we must have a firm understanding of all aspects of our use of color; having a section that lets the designer know what colors are safe to use is vital to this entire project.

APP



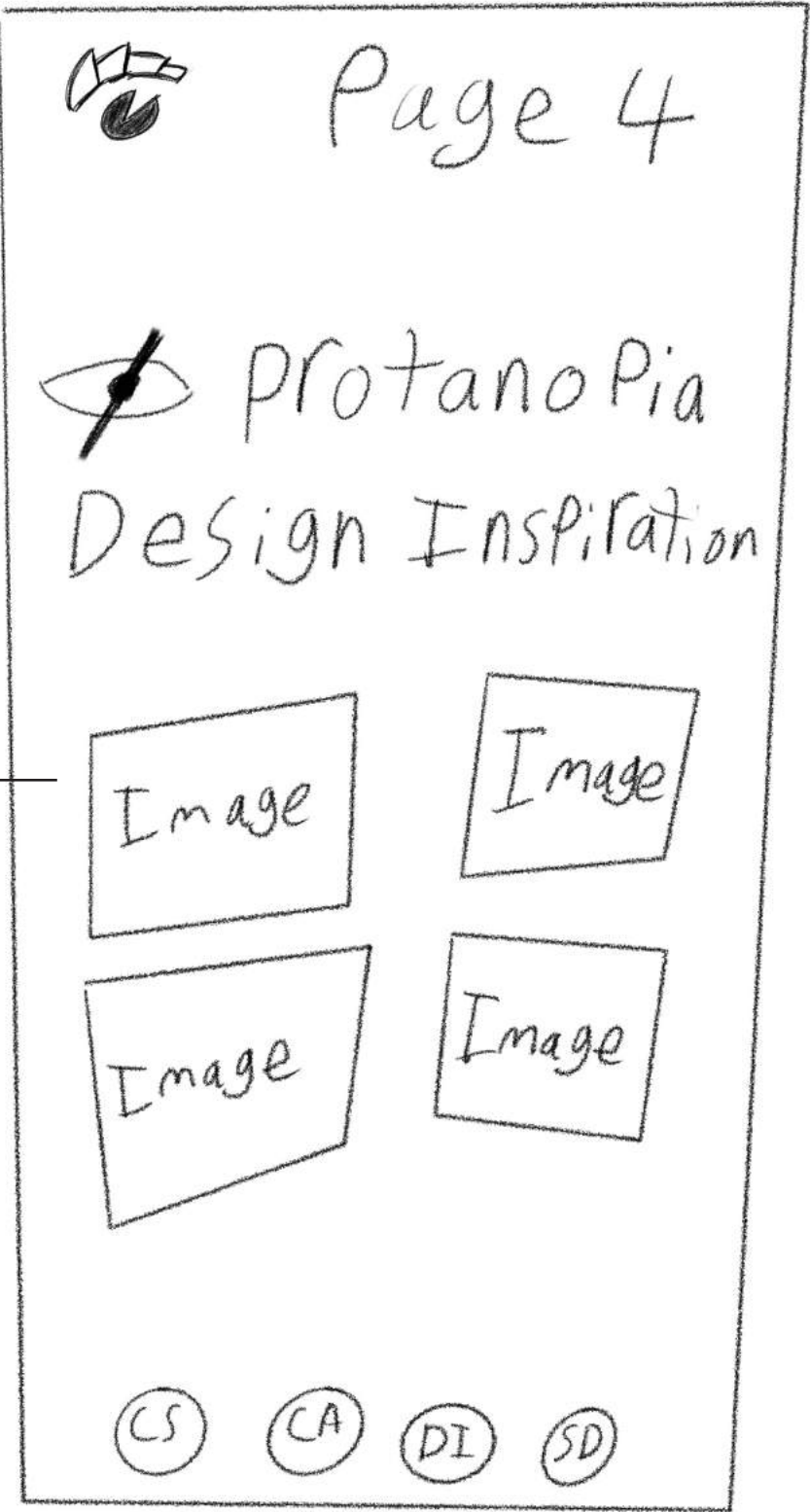
APP




While knowing what colors work for those with each specific deficiency is essential, it is almost equally important to know what colors are harmful to use. In this section, the user will not only get information on what colors they should avoid but have a visual example of why they should avoid them by showing how the the the individual would see them.


Do not reinvent the wheel! While I was first stepping into the world of graphic design, I wondered how someone could continuously look at a blank page and create such fantastic work. It took far longer than I would care to admit for me to learn that mood boards and inspiration from other works are essential for most of us. This section is meant to function like Dribbble or Pinterest and provide the user with color-blind friendly designs using palettes for each specific deficiency.


APP



APP

 Page 5

 protanopia
Share Designs

 Attach Files

Submit

CS

CA

DI

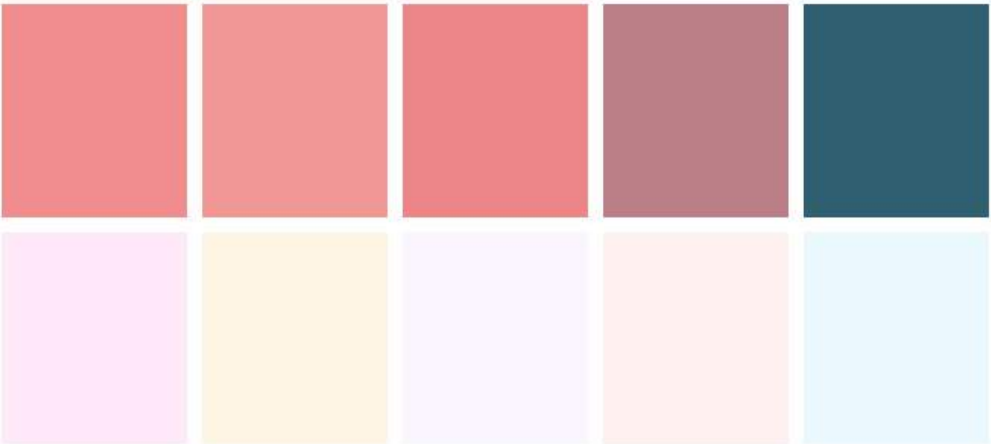
SD

The graphic design community is a bit paradoxical. While it is a rather cutthroat industry, ironically, it also functions a lot like a family. Most designers are always ready to help inspire, teach, or otherwise lend a helping hand to their fellow designers. This is the idea that I wanted to center this section around. Ultimately, as an individual, I want to help others, and this is a way that we can all contribute to that same mentality, providing our color-blind friendly designs for others to see and hopefully to help inspire each other.

App Protoype

Styleguide

Colours



I decided to make a quick style guide, which I used in addition to the one I made for the logo development, this one I made in Adobe XD as to have the resources right there for buttons and such.

Character Styles

Main heading text

Highlight text
Subtitle

While I loved the Forma typeface that I used in the logo design, I decided to go with a type that has a bit more readability for the rest of the application. So, I decided to go with a typeface called Lato. It is a clean and modern font that looks great digitally.

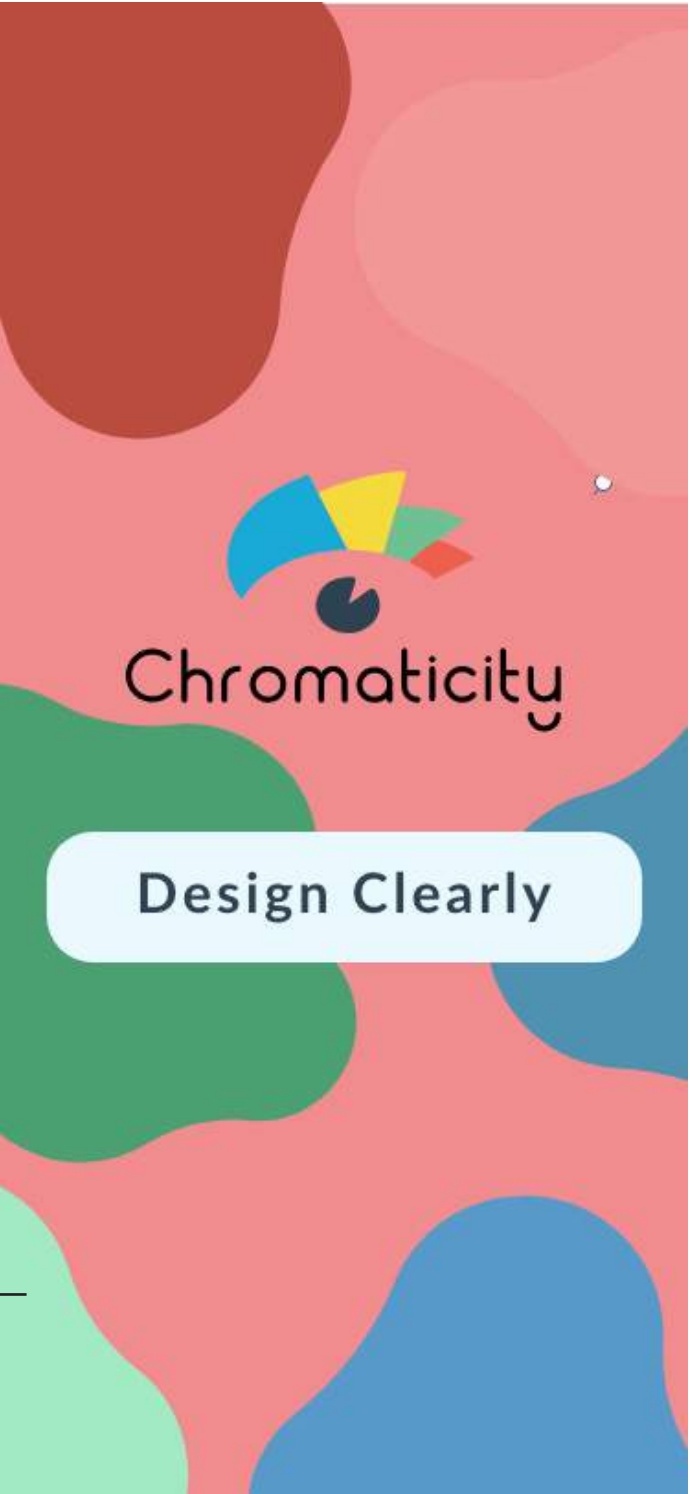
Icons



Buttons



The digital iteration of the loading page did not change at all. The only difference is the phrase on the button and the background colors. With the button, I wanted to reinforce the idea that this is a tool to help designers create more inclusive designs that are clear to all individuals. The background colors were added to associate with the deficiency colors: red, green, and blue.





The digital iteration of these pages did not change, as you will see from the pages here. Each page from left to right is following the natural flow of the application. However, the user can jump around to any page they want to avoid the descriptive page and go straight to the section where they can upload their work should they so choose.

ChromatiCity

Tritanopia

Color Schemes


Types color-blindness

Protan

Deuteran

Tritan

Protanopia is a type of color-blindness where the individual has difficulty distinguishing blue-yellow colors. This means that the individual will see things in red and cyan hues.



Color Schemes

Color Avoidance

Design Inspiration

Share Designs

Use these tritanopia friendly colors schemes to bring the best out of your designs!

#E6E6FA	#ADD8E6	#FF0000
#800080	#008080	#000000

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Colors to Avoid

Tritanopia

Since those with tritanopia have difficulty with yellows and greens, try and avoid using those colors. As you can see below, it is perceived very differently!

#FFFF00	→	#FFC0CB
#008000	→	#00BFFF

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Inspirational Designs

Tritanopia

Need some inspiration? We've got you!





Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Share Your Work

Tritanopia

Submit your tritanopia friendly designs and help inspire others!

Attach File Here

Submit →

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Deutanopia

Color Schemes


Types color-blindness

Protan

Deuteran

Tritan

Protanopia is a type of color-blindness where the individual has difficulty distinguishing the color green. This means that the individual will see things in blue and yellow hues.



Color Schemes

Color Avoidance

Design Inspiration

Share Designs

Use these deutanopia friendly colors schemes to bring the best out of your designs!

#FFDAB9	#FFD700	#8B4513
#9370DB	#4169E1	#191970

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Colors to Avoid

Deutanopia

Since those with deutanopia have difficulty distinguishing reds and greens, try and avoid using those colors. As you can see below, it is perceived very differently!

#FF0000	→	#8B4513
#008000	→	#DAA520

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Inspirational Designs

Deutanopia

Need some inspiration? We've got you!





Color Schemes

Color Avoidance

Design Inspiration

Share Designs

ChromatiCity

Share Your Work

Deutanopia

Submit your deutanopia friendly designs and help inspire others!

Attach File Here

Submit →

Color Schemes

Color Avoidance

Design Inspiration

Share Designs

8.

Bibliography

B. Hampshire, The design and production of tactile graphic material for the visually impaired, In Applied Ergonomics, Volume 10, Issue 2, 1979, Pages 87-97, ISSN 0003-6870, [https://doi.org/10.1016/0003-6870\(79\)90059-0](https://doi.org/10.1016/0003-6870(79)90059-0). (<http://www.sciencedirect.com/science/article/pii/0003687079900590>)

Bolt, David. "An Advertising Aesthetic: Real Beauty and Visual Impairment." British Journal of Visual Impairment, vol. 32, no. 1, 8 Jan. 2014, pp. 25–32. Sage Journals, doi:<https://doi.org/10.1177/0264619613512619>.

Bruce, I., et al. "Blind and Partially Sighted People's Perceptions of Their Inclusion by Family and Friends." British Journal of Visual Impairment, vol. 25, no. 1, 1 Jan. 2007, pp. 68–85. Sage Journals, doi:<https://doi.org/10.1177/0264619607071778>.

Busch, Akiko. "Designing for disability." Print, vol. 49, no. 2, Mar.-Apr. 1995, p. 44+. Gale Academic OneFile, https://link-gale-com.ezproxy.liberty.edu/apps/doc/A17051554/AONE?u=vic_liberty&sid=AONE&xid=2392c248. Accessed 10 June 2020.

Conrad, Trevor E. "Beyond Braille: Graphic Design for the Visually Impaired." The Savannah College of Art and Design, 2012.

E. Steinbach et al., "Haptic Communications," in Proceedings of the IEEE, vol. 100, no. 4, pp. 937-956, April 2012, doi: 10.1109/JPROC.2011.2182100.

Dong, Hua, et al. "Designing for Designers: Insights into the Knowledge Users of Inclusive Design." Applied Ergonomics, vol. 46, 2015, pp. 284–291., doi:10.1016/j.apergo.2013.03.003.

Heylighen, Ann, and Matteo Bianchin. "How Does Inclusive Design Relate to Good Design? Designing as a Deliberative Enterprise." Design Studies, vol. 34, no. 1, 2013, pp. 93–110., doi:10.1016/j.destud.2012.05.002.

Jakoubě, Helena. "Graphic Design Approaches for Visually Impaired People." Bulletin / 2012.3 5–34. Web

L. Gómez-Robledo, E. M. Valero, R. Huertas, M. A. Martínez-Domingo, and J. Hernández-Andrés, "Do EnChroma glasses improve color vision for colorblind subjects?," Opt. Express 26, 28693-28703 (2018)

Raudoniene, Dijana. "The Process of Graphic Image Creation in the Conditions of NonSeeing." British Journal of Visual Impairment, vol. 32, no. 1, Jan. 2014, pp. 14–24, doi:10.1177/0264619613516020.

Ravenscroft, J. (Ed.). (2019). The Routledge Handbook of Visual Impairment. London: Routledge, <https://doi-org.ezproxy.liberty.edu/10.4324/9781315111353>

Sayei, Nadja. "Building Braille." Print, vol. 69, no. 4, Fall2015, p. 58. EBSCOhost, ezproxy.liberty.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=f5h&AN=111020802&site=ehost-live&scope=site.

Strickfaden, Megan and Aymeric Vildieu. "On the Quest for Better Communication through Tactile Images." The Journal of Aesthetic Education, vol. 48 no. 2, 2014, p. 105-122. Project MUSE muse.jhu.edu/article/544114.

Wong, Bang. "Color Blindness." Nature Methods 8.6 (2011): 441. ProQuest. Web. 27 June 2020.

Yan, Ru Shan. "Research on Touch Experience Design in Graphic Design." Applied Mechanics and Materials 121-126 (2011): 4742. ProQuest. Web. 11 June 2020.

Appendix

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Color pencils set

Thesis

Aug 20, 2020

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Well-loved colorful watercolor paint palette travel kit with paintbrush.

Thesis

Oct 4, 2020

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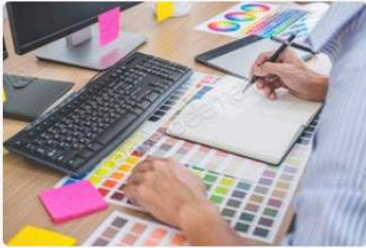



Image of male creative graphic designer working on color selection and drawing on graphics tablet at

Thesis

Oct 4, 2020

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White cards with printed question marks

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Designer are presenting creative ideas

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Exhibition visitors at contemporary art gallery

Thesis

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	Flat Design Illustration - Digital Art	Thesis	Oct 3, 2020	<div>Download ADD A LICENSE</div>
	Art Gallery - Building Illustration	Thesis	Oct 3, 2020	<div>Download ADD A LICENSE</div>
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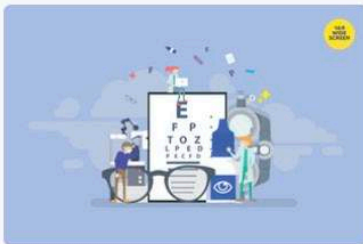
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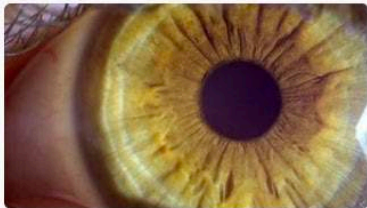
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