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The Whose View of Hue?:

Disability adaptability for color blindness in the digital game Hue

ABSTRACT
Hue is a successful digital game from the independent game company, Fiddlesticks, that is focused around color theory. The game's core concept, however, made digital game play impossible for players who are colorblind. *Hue*'s built-in and customizable game modes allow colorblind players to use patterns instead of colors to play the game. Through an interview with *Hue*'s creator Henry Hoffman, this article details Hoffman's design process and proposes a framework for accessible game design based in universal design principles.

KEYWORDS: *Game Design, Accessibility, Universal Design, Color Blindness, Hue.*

INTRODUCTION

Digital games are currently one of the largest sectors of the entertainment industry, with a U.S. market value of $18.4 billion in 2017 (Statista, 2018). Bierre et al. (2014) note, however, that the digital game industry excludes a significant portion of consumers because of the difficulty of making many games accessible to players with disabilities. Yuan et al. (2011, p. 86) estimate the number of people whose ability to play digital games is impaired by disabilities to be 32.2 million, or 1% of the total U.S. population. While assistive technology solutions, such as screen readers, magnifiers, voice recognition systems, and adaptive controllers and keyboards exist, many of these technologies are not compatible with widely used game consoles and popular games themselves. There is a need, then, to consider not only the ways to adapt a game for players with disabilities after it is produced, but to integrate considerations of disability within the design process itself.

This paper considers the process through which one digital game designer approached adaptations of the popular digital game *Hue* (2016) for players with one particular disability: color blindness. Through an analysis of an interview

with the game designer Henry Hoffman, this article considers the ways that Hoffman's design process follows principles of Universal Design (UD), an approach to disability adaptation that considers accessibility at the beginning of the design process. Hoffman's example provides a model for other game designers to follow in developing successful games that are accessible for players with specific disabilities.

ACCESSIBILITY IN GAMING DESIGN

While accessibility and accessible design are growing areas of concern in education, education technology, and other areas of digital technology, digital games are a bit behind in addressing the needs of individuals with disabilities. The W3C set accessibility standards for websites worldwide, but digital games have more specific and often idiosyncratic requirements. Yuan et al. (2011) note the difficulty in improving accessibility in digital games; technologies and consoles change frequently and use different configurations and hardware. Digital games also are doing more than simply presenting information to the user, and they also require interaction through user feedback (Yuan, 2011, p. 82). Some players can use alternate input devices, including eye controllers and vocal joysticks, but these devices usually have limitations on the amount and type of input that the device can record.

Yuan et al. (2011) propose that games that need just one form of input, called one-switch games, can be easiest to make adaptable, especially for players with visual or motor impairments who use alternative input devices; a few of these popular games include remakes of earlier classics, including *Frogger*, *Sudoku Access*, and *Gordon's Trigger Finger*, a modification of the FPS game *Half-Life 2*. Bierre et al. (2014) also surveyed game developers on specific games that were designed with accessibility in mind. Like Yuan et al., these scholars mentioned a number of games that have been adapted from commercial titles in order to shape gaming experiences for individuals with specific types of disabilities. They also described popular commercial titles with adaptations for players with disabilities, including *Half Life 2*, with closed captioning options tested in collaboration with deaf players; *Doom 3*, with a closed caption modification developed in collaboration with players after the game's release; *Terraformers*, created with a sonar system for vision-impaired players; and *F355 Ferrari Challenge*, with an intelligent braking system for players with slower reaction times (p. 8-9).

COLOR BLINDNESS IN DIGITAL GAMES

Color blindness, which affects nearly 15% of Caucasian males (Zammitto, 2008, p. 272), has not only proven problematic for digital game creators, but is often ignored for commercial or production reasons, or much less even considered to be an issue. When digital games do adapt to players' needs, rarely do they make any news about it, nor is it much beyond a cursory notification in the game's instruction manual. Scholars such as Tanuwidjaja et al. (2014) have

investigated the issue at length, designing Chroma, a Google Glass inspired technology to provide "real-time textual feedback about the color at the center point of the scene" (Tanuwidjaja et al., 2014, p. 801). Another app on iTunes Tanuwidjaja et al. (2014) mention is HueVue, which helped the colorblind "to identify, match and coordinate colors" in addition to providing detailed color information just by touching any image. (Cnet, 2010).

Several other studies have examined these issues within game design (Duvall, 2001), players with disabilities (Lim and Nardi, 2011), and even eye testing in children (Gaggi and Ciman, 2016). While these technologies do make exceptions for individuals who are colorblind and make various media more palatable and usable by those with this particular disability, they invariably work as add-ons, as secondary technologies. Disability studies scholar Jay Dolmage (2008) calls such approaches "retrofitting":

> To retrofit is to add a component or accessory to something that has already been manufactured or built. This retrofit does not necessarily make the product function, does not necessarily fix a faulty product, but it acts as a sort of correction. (p. 20)

While these technologies can assist players who are colorblind in playing the digital game more effectively, they do not solve the underlying problem that makes the digital game inaccessible to a portion of the gaming market.

UNIVERSAL DESIGN

Universal design (UD) is a broad set of design principles used in architecture, technology, and education to create spaces and objects that take into consideration the needs of differently-abled and older adults. The core tenant of universal design is to start from the earliest stages of a product's design to take into consideration how different sorts of users might use the space or object. By foregrounding concerns of accessibility, designers can create products that work for the widest range of people possible. The most recognizable and perhaps ubiquitous of these adaptations are curb cutouts. The Center for Universal Design at North Carolina State University (1997) has developed the following best principles for universal design:

1. Equitable use
2. Flexibility in use
3. Simple and intuitive use
4. Perceptible information
5. Tolerance for Error
6. Low physical effort
7. Size and space for approach and use

These principles, as a whole, allow for multiple approaches and means for reaching an objective. Whether it is creating a space with wide hallways and movable furniture to accommodate wheelchairs and other assistive devices, or al-

lowing for user error and multiple approaches, the overall objective is to provide flexible, user-friendly objects for all individuals, not just those with disabilities.

While universal design principles were first developed for architecture, they have been applied to other fields, including education and educational technology. UD approaches in these areas may be the most productive to consider for digital game design. Dolmage (2015) argues that anyone utilizing universal design for education needs to consider three broad principles in its creation that will avoid problems of retrofitting and ensure the most accessible approaches:

- *Multiple means of representation*, to give learners various ways of acquiring information and knowledge,
- *Multiple means of expression*, to provide learners alternatives for demonstrating what they know,
- *Multiple means of engagement*, to tap into learners' interests, offer appropriate challenges, and increase motivation. (Dolmage, 2015)

While Dolmage's framework is specific to instructional design and delivery, the principles are broad enough to provide a flexible framework for game designers. Considering multiple means of the representation of information as well as multiple means of engagement will allow digital game players to customize digital games to fit their needs, whether it is closed captioning on a digital game (as a differentiated means of representation) or through multiple possibilities for player controls or inputs (as multiple means of interaction). Taking these issues into account early in the design process provides more flexibility and possibilities for meeting accessibility needs than those available later in the process.

HUE

Indie developer Fiddlesticks and publisher Curve Digital made their commitment to an adaptive technology from the start with their digital game *Hue*, a runaway hit, both commercially and critically. As the protagonist Hue, the player explores a gothic story of a boy searching for his missing mother through world of black and white environments that can be manipulated with a color wheel that is slowly filled in with various colors as the game progresses. Obstacles can disappear and reappear with a turn of the wheel, or reveal new puzzles to solve, as the game increases in difficulty all while adding eight colors: Blue, Dark Blue, Purple, Pink, Orange, Red, Yellow, and Lime. The very first press release describes the game as, "A heartfelt story that touches on themes of love, loss, existence and remorse" with "Over 30 original music tracks, composed exclusively for Hue." The designers explicitly state that *Hue* features "full colorblind support, using symbols as a color aid" (Hue, 2016).

Creator Henry Hoffman has noted this was a key consideration in making the game. "After much research, testing, and seeking advice from color-blind communities, we devised a simple symbol system which we hope will make the game accessible to all. We really want as many people as possible to enjoy Hue"

(Musa, 2016). The rest of this article details the design process for this specific digital game specifically.

METHODOLOGY

In order to more fully consider the ways that accessibility for players who are colorblind colorblind players was incorporated into the design process for *Hue*, I conducted an interview with *Hue* creator Henry Hoffman, the Creative Director and Co-Founder of indie game developer, Fiddlesticks. I spoke with Hoffman at length over Skype and asked questions regarding the development of Hue and the design process. The interview was transcribed, and I analyzed the transcript for common themes. While the experience of one designer cannot be extrapolated to the experiences of other game designers, as a case study Hoffman's experience can identify trends and questions for further inquiry.

INTERVIEW DETAILS

Hoffman explained that the central concept of the digital game was color theory. He noted that he begins a game around a central concept or mechanic, and then builds the game from there:

> I've got a very consistent approach to game design in that what I find most interesting about game design is coming up with new ways to interact with things that haven't been interacted with before. So, for me, it's all about devising interesting game mechanics that haven't been explored. [. . .] In *Hue*'s case, what I was doing is I had PhotoShop open I think, and I had sort of a color fill background, and I had a layer with something on, and I was just sliding the hue slider around on one of the layers, and I noticed that as the hue of the foreground layer matched the hue of the background layer, it kind of visibly melted and disappeared into the background. And I thought it would be interesting, as a game mechanic, if it also physically sort of disappeared.

Hue as a game, then, was based around color as a central concept. Zammitto (2008) has noted the ways that digital games traditionally have relied on color to communicate meaning, for example, using the color red for danger when the player's health bar gets low. In *Hue*, however, the central game mechanic requires the player to switch between color backgrounds. In the game, as noted above, players unlock an array of colors and switch between them as they play, making the objects appear and disappear based on their own colors. The game's central concept is based on color, so the game has an immediate accessibility problem for those players with colorblindness.

Hoffman reported that he discovered this issue not in the initial design process, but during initial testing:

> So, I don't have a background in game accessibility at all, so I was just kind of

> thrust into this without any real notion that this was going to happen. […] When I started taking it to game conventions very early on, I think we had a five-minute demo that I put together in two weeks, and I took it to game convention just to get some player feedback, and it was immediately apparent that a large amount, a substantial amount or a percentage of people were struggling to play the game, and that was due to their inability to differentiate between different colors due to colorblindness–various forms of colorblindness.

Hoffman noted that he doesn't necessarily know anyone with colorblindness, and he had not initially anticipated that it would be an issue with this particular game. As a small developer, Fiddlesticks does not have a quality assurance (QA) department, but the company instead tests their games at various conventions and events with real players, which is where he first found colorblindness to be a problem with *Hue*.

After this discovery, Hoffman sought out players who are colorblind for advice on how to address issues of accessibility with this group, as well as game testing:

> On Reddit, there's a colorblind subreddit, and I posted a video, a really early video of the gameplay, and I was like, "Guys, I think I created your worst nightmare. Can you please help me?" And they provided loads of feedback, lots of people offering to do game testing. People came up with the idea of using symbols, using patterns. I actually experimented very early on with using patterns, which are a much simpler aesthetic, having sort of a pattern overlay over each different color and being able to match those patterns. But then as the aesthetic developed and we got these intricate details, overlaying patterns became too much visual noise, and even people who weren't colorblind struggled to play the game. So, I was like, okay, that's not going to work. So I ended up devising sort of this symbol-based system, my own symbol-based system, which ended up getting a substantial amount of press, which I'm very happy about.

Universal design principles advocate for an inclusion of users in the design process, as Dolmage (2015) has noted. While Hoffman did not anticipate accessibility issues when designing *Hue*, he was quick to reach out to individuals with colorblindness to come up with a solution that worked for them. He included these users in the design and troubleshooting process in order to make sure that his solution was 1) flexible; 2) intuitive; and 3) easy to use, all key principles of universal design. What is especially notable about this example is that the solution came not from Hoffman or the other game designers, but instead was a suggestion from the community itself.

Hoffman reported that he found these players, particularly players who are colorblind, essential to the design and development process:

> I think we wouldn't have even recognized that there was an accessibility issue unless we had that dialogue in the very beginning. So, it was super important to get people in front of it. And I think the aesthetic – and the world itself, the world building itself – constantly developed when we were showing it to people. We showed it at 40 different events throughout the development of *Hue*, and in that process, we just got such huge amounts of feedback.

Universal design principles, as described by the Center for Universal Design (Connell, 1997), at their core are simply best practices for design. Applying these principles to digital game design, involving users at all stages of the design process, and incorporating their experiences, can create better gaming products and experiences. In this example, Hoffman found the testing phases with players to be important not only for issues of accessibility, but also for refining other elements of the digital game as well. He also found the accessible features to be incredibly successful; players rated the adaptations highly, and they were also utilized by other players, not just those with colorblindness:

> There's been a huge response. We've had colorblind streamers who have streamed the game and sort of expressed support. There's been players that have got no vision impairment whatsoever who turn on colorblind mode just because they prefer it, because it's another form of visual reinforcement.

While many features of accessible design, including the curb cutouts mentioned above, are created for those users who need accommodations, they assist all users, and many individuals who do not have specific disabilities also use and appreciate the adaptive features.

These design experiences have given Hoffman a sense of the importance of building accessible games, and not just for players who are colorblind He also described another situation that caused him to understand the need for flexible, accessible design:

> When I came into this, I had a vague awareness of accessibility but I didn't realize quite how important it was and how pervasive some of these things that people can suffer from are. And I think one of the most notable things I remember is our showcasing … in London, and there was a player with a physical disability who wasn't able to use a keyboard and mouse, and I don't think they were able to use an analog stick on a controller. So, at that point we didn't have accessible controls, so he wasn't able to play the game at all. He was really disappointed, and you could see that he was really excited to play the game, and then the disappointment when he physically wasn't able to. That, for me, was a real eye-opener, and because of that we added accessible controls, which allows players to sort of personalize the controls so that they can play how they like.

This comment demonstrates the importance of building flexibility into the game design process wherever possible. While many players may not need or use these controls, they can be crucial for those who do need them. Hoffman's experience here demonstrates how he learned firsthand the importance of accessible game design.

While the importance of accessible design is clear, these adaptations can certainly cost money. For small developers reliant on funders for project development, decisions about accessibility ultimately come down to cost. Hoffman noted that the positive attention *Hue* received because of its accessibility features have made the game more commercially successful:

> We even released promotional videos sort of speaking game accessibility, and if you look at MetaCritic, what's really interesting, and this is something that I say often when giving talks about accessibility features is that, as a small studio and developer, when you've got other people's money on the line, you need to make a business case for accessibility features. And if you're willing to accept that your MetaCritic rating directly influences your sales, if you go through our MetaCritic reviews, every single positive review praises the accessibility features. So, I think there's a huge business case.

While building accessibility accommodations into digital games can open them to a different audience, they can also make the games more marketable. That feature, more than ethics of accessibility, can be a driving force in increasing accessibility in digital games.

Hoffman described accessible game design as a growing area, and one driven by this commercial viability:

> I think a lot more people are starting to realize that if you make games as well, because you're making games and small elements of these games aren't sort of accessible, and they're realizing that players aren't able to play the games and those players are disappointed, so I think there's a kind of a collective awakening. […] I think the bigger studios are going to be looking at the bottom line, and I think the game designers are probably going to be pushing for making the game accessible so more players can enjoy the game. I think there's going to be arguments coming from all sides because it just makes sense. Like there's no argument against it at this point.

As Neely (2017) argues, digital game designers can no longer afford to ignore concerns of disability and accessibility when it comes to design. The broader appeal of digital games, and the need to make them adaptable to players' abilities, make this a required issue in the marketplace.

While making accessible games are important to Hoffman, accessible design is a secondary concern to the overall game design itself:

> But I think, for me, what's important about accessibility is that you're not compromising the game design vision in order to make a game more accessible. What you're doing is just allowing as many people to play your vision as possible without compromising the game. For me, game design comes first, and making it accessible is sort of a really high priority after that.

Hoffman's primary concern is to build a digital game that fulfills his vision, and then he works to build accessibility accommodations. While they do not come first in his own game design, when integrated early enough in the process they can enhance and even improve the game overall. In the case of *Hue*, building a pattern-based alternative to the color backgrounds and the subsequent testing with players with different abilities improved the game as a whole. It also created an important market and marketing approach for the game after its release. Working to make *Hue* more accessible built a better game.

Henry Hoffman provides just one example of a digital game designer who was confronted with issues of accessibility and worked to adapt. We can learn a good amount about accessibility issues in design, however, by considering his experience. The main findings of this interview are as follows:

1. Hoffman described the central concept of *Hue* to be color theory.
2. Hoffman first discovered accessibility issues with color during initial game testing with an early version of *Hue*.
3. Hoffman approached players with colorblindness to develop a solution for his game design and involved these players in the design process.
4. Hoffman solved these accessibility issues by offering a pattern option rather than a color option.
5. Hoffman saw accessibility as a central concern for all digital game designers, one that will help a game to reach more audiences and also to perform more successfully in the competitive digital game market.

Hoffman noted that he came to these issues in game design organically. Because he emphasized color as his central game mechanic, he soon learned that this design feature was a limitation for many players. His process in solving this problem by involving players with colorblindness themselves is a strategy recommended by many experts in universal design and can serve as an example for other designers.

CONCLUSIONS

Henry Hoffman's introduction to issues of accessibility in digital game design was based on his first-hand experience with different players. While designing games for individuals with disabilities was not a primary goal of his, he turned to accessible design as a means to solve a problem. While Hoffman's experience cannot stand as representative for all designers, and we cannot extrapolate beyond his experience, his emphasis on both the positive press he received from *Hue's* accessibility features, as well as the financial argument for accessible

design brings up issues of concern for many in the digital game design industry. Pitaru (2008) notes the importance of accessible game design, which is still a neglected issue in industry. As Pitaru argues, "even the slightest impairments can severely compromise [players] ability to play mainstream games" (p. 75). As accessible design is becoming a larger concern, and even a market for digital games, it's worth considering not only the process of game designers in approaching accessibility accommodations, but also ways to incorporate accessible, and in fact universal, design throughout the creation process.

While these concerns were not in the forefront of his mind or his experience, Hoffman's approach to *Hue*demonstrates the flexibility and usefulness of universal design principles for game design. As Hoffman described, he had a short mockup of the game when he began testing it with different groups of players and discovered the color issue for players who are colorblind. This realization early enough in the design process allowed Hoffman to incorporate the needs, concerns, and even ideas of players who are colorblind in order to create a more accessible gaming experience. As advocated for by many universal design proponents (Connell, 1997; Dolmage, 2008, 2015), Hoffman worked with the community of individuals who are colorblind, and the solution to his accessibility problem came directly from this community itself. While the pattern innovation helped players who are colorblind, it also helped other players as well in providing customization and allowing for ease of use. *Hue* has won several awards: the Develop Indie Showcase 2015 as well as the Develop Indie Showcase, Game of Show and Best Art at Casual Connect USA, and Best Design at Casual Connect Europe. *Hue* serves as a model for the ways that digital games, even those from small and indie developers, can excel both creatively and commercially by embracing accessible design.

Universal design principles and approaches present what I argue is a productive approach for digital game design. Jay Dolmage (2008, 2015) advocates for design approaches that allow for multiple means of input, multiple means of output, and multiple means of interaction. Considering these approaches at the beginning of the design process can not only avoid the issue of retrofitting, but it can also ensure ease of use for players with a wide range of disabilities. Testing the game throughout the process with a wide range of players will allow designers to see these approaches in action and allow for troubleshooting as well.

Hue and Hoffman's experience also emphasizes the importance of leaning on the community of individuals with disabilities for support, not only for testing the game, but also in solving accessibility challenges. It is notable that in this case, as described by Hoffman, the ultimate solution for issues of colorblindness came from players who are colorblind themselves. This experience demonstrates how crucial it is to include the community of individuals with disabilities into the design process, in order to create flexible games with multiple means of both representation and interaction. As accessibility becomes a larger and larger issue within digital gaming, as

Pitaru (2008) and Neely (2017) argue, building a comprehensive approach to accessible game design is becoming more crucial. In these ways, *Hue* can serve as a model for successful possibilities for other game designers.

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