

Animating Representation: Diversity in Computer Graphics Technology and Storytelling

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Research Paper

Technology and Diversity in Storytelling

Media representation is key in the development of social identity and attitudes regarding seemingly disparate social groups (Brooks & Hébert, 2006). This phenomenon is especially true in children, who are quick to connect themselves to representations that they feel they share similar traits with (Keys, 2016; Signorielli, 1990). This effect is magnified for those in disadvantaged or underrepresented groups (Schmader et al., 2015). However, while racial diversity in media such as animated films has increased in terms of quantity in the past decade, the quality of that representation must also be analyzed to create a comprehensive view, yet this can be more difficult to measure (Smith et al., 2018). One factor that is often considered when performing more detailed analyses of representation in media is the centrality of creators from the represented groups to leadership roles within the project (Erigha, 2015). Another factor that can shape storytelling is the tools that creators are working with. These are especially influential in the realm of 3D animation and computer-generated imagery (CGI), as the software can dictate what type of stories can be told (Villemin et al., 2015).

This paper addresses the following research questions: What racial biases are present in computer graphics and animation technology and the media created with this technology, and how have these biases been sustained and molded by technology? What are their implications on the stories told through computer generated media? In order to shed light on the cyclical relationship between societal values, graphics technology, and media representation, these questions are explored within the analytical framework of Co-Production.

Methods

To answer the research question, documentary research and discourse analysis are performed utilizing Jasanoff's four ordering instruments of co-production theory as an organizational framework (2004). Preliminary analysis is based on that of Kim et al. (2021) and primarily focuses on clearly identifying evidence of the issue in current literature through documentary research. A survey of graphics research papers in the Association for Computing Machinery's (ACM) Digital Library that focus on human and human feature rendering, simulation, and animation is conducted. This survey aims to gather more data regarding the presence, and absence, of examples and discussions of features that are characteristic of typically underrepresented groups in graphics research. Another survey brings attention to independent and smaller scale creatives, examining tools and software packages popular amongst smaller animators and game creators such as Blender and Unity.

Informed with increased clarity regarding the present standing of the issue, further documentary research and discourse analysis is conducted to investigate the historical relationship between bias, animation technology, and animated media, and the role of this relationship as a precursor to these current forms of bias. Additionally, a review of how shifting societal values are reflected in changes in discourse surrounding large studios and technological development is completed. Keywords guiding this analysis include: animation, bias, diversity, graphics technology, race, and representation.

Bias in Storytelling

Even in an increasingly globalized entertainment market, the American film industry, specifically Hollywood, has continued to enjoy a uniquely international reach and influence

unmatched by film industries of its competitor countries since the early 1900s (Benshoff & Griffin, 2004; Crane, 2014). Hollywood's continued cultural domination, both in the US and abroad, is a result of a history of outcompeting and overtaking both foreign and independent American filmmakers, made possible by the oligarchic structure of the industry, wherein a few major film studios form the basis of the entire industry. The studios that form this oligarchic base maintain power through their ability and resources to control production, distribution, and exhibition of their films, which in general is unimaginable for smaller creators, and also allows these studios to beat out local productions in foreign markets as well (Benshoff & Griffin, 2004). In an even more exaggerated reflection, Hollywood animation has also dominated animated films. At an international level all of the 100 top grossing animated movies worldwide, 93 of which used 3D computer-generated animation, were created by one of roughly seven American animation studios ("*Genre Keyword: Animation,*" n.d.). Due to the influence and power over global animation markets that Hollywood animated media has, this research paper generally centers around Western animated films created in Hollywood.

As a result of Hollywood's structure, the individuals who lead the major studios have an immense amount of power over the narratives and ideologies that the industry as a whole puts out. Historically, these individuals have been White men, who have tended to disseminate stories that "uphold white patriarchal capitalism" (Benshoff & Griffin, 2004, p. 31). As such, while non-White people can be seen in big-budget films all throughout the industry's history, these represented groups often had little to no control over their images, leading these representations to often be stereotypical and further marginalizing these groups in mainstream media (Benshoff & Griffin, 2004; Gateward, 2000; King et al., 2010). This pattern was exacerbated in American animation. While non-White filmmakers began producing and distributing movies fairly early on

in film history, albeit not to the extent of the larger Hollywood studios, non-White people were not really seen in the animation industry at all, even as non-White racialized animated characters quickly became a staple of the medium. Subsequently, stereotyping and misrepresentation continued to infiltrate animated media (Barker, 2010).

The preferential treatment of White narratives by White creators led to, and perhaps was in turn further influenced by, media technology that also inherently favored Whiteness. Social biases and norms regarding race have been baked into media technology as early as the popularization of the color camera, with the creation and usage of “Shirley cards” in the 1950s by the Kodak photography company (Mars, 2021; Roth, 2009). Shirley cards are images used to calibrate cameras during their production in order to ensure that colors and lighting were captured properly. Their name is derived from that of the subject of the first of such images—a White woman by the name of Shirley Page. In the decades following, Shirley cards continuously featured White women exclusively, causing the cameras and printers calibrated with these cards to be biased toward the depiction of lighter skin tones. As a result, early color films fail to depict people with darker skin tones with the same amount of clarity afforded to those with lighter skin tones (Roth, 2009). In addition to the physical camera and film technology being primed for best capturing light skin tones, standard lighting practices and camera setups in the industry have also historically been optimized for light skin tones (Mars, 2021; Kim, 2021). While these biases can occasionally be overcome by special makeup and lighting techniques, they add an implicit barrier preventing non-White people from entering into film. If evidence of social biases can be found in traditional film technology, what biases might be found in graphics and animation, a medium that is even more heavily reliant on the technology it is created with?

Racial biases present in film history surround the formation of the field of animation and graphics. This paper aims to identify and contextualize existing biases in the animated medium, from the academic field of graphics to the media produced.

The Co-Production Framework

Co-Production theory is used to analyze the relationship between developments in computer graphics technology and representation in animated media within the broader social context of a globalized and digitally connected societal landscape. First introduced by Sheila Jasanoff in 2004, co-productionist theory emphasizes the recursive nature of the relationship that exists between social and technological order, and uses this observation to examine how both spheres develop in tandem (Jasanoff, 2004, p. 22). Jasanoff writes about the role of scientific knowledge as a reflection of the society it was developed in, rather than as an unquestionably true representation of the natural world, stressing the importance of recognizing that as a result, scientific knowledge itself carries implicit messages that should be closely examined (Jasanoff, 2004).

The broad definition of co-production allows the framework to lend itself to a variety of ordering instruments. Of these, four that are useful to this analysis are: the making of institutions, discourses, representations, and identities (Jasanoff, 2004, p. 38).

Scholars have used co-production to analyze a variety of large-scale issues. Mager uses co-production to dissect the complex and dynamic relationship between Internet search engine technology and the making of a European identity. Mager favors the use of co-production in this analysis due to its ability to express the dynamic interwoven interactions between policy, technology, and identity (2016). Similarly, Bremer and Meisch (2017) identify the theory's

definition and focus on the complicated nature of the interactions between knowledge and institutions as a strength which allows it to be used in framing complex, multi-faceted societal issues. However, Bremer and Meisch also note that co-production theory's broad definition can cause attempts to aggregate co-productionist studies for any single topic messy, as different scholars are able to fit the framework to several different facets of any given argument. Bremer and Meisch highlight the possibility of the latter phenomena in their study the use of co-production in several discussions of climate change policies, and identify several different lenses through which co-production is often applied. Bremer and Meisch conclude that scholars who choose to use co-production need to clearly articulate which lens, or lenses, they will use in their analysis in order to best explore the rich analyses the framework can support. In terms of Bremer and Meisch's lenses of co-production, this analysis falls into the two "descriptive" lenses that are identified. The constitutive lens is used to analyze how graphics technology shapes representations of ourselves and the natural world. The interactional lens focuses on the evolution of graphics technology with wider social institutions (Bremer & Meisch, 2017).

The Co-Production of Animation, Technology, and Societal Values

Racial biases and stereotyping in animation are traced to the beginning of the medium. These biases have continued to be perpetuated in popular animated media, and the historical context from which they stem has also caused similar biases to be embedded into the technology used to create animation and norms surrounding the industry. Researchers and developers must be educated of these embedded biases in order to create equitable technology that allows for people of all background to further explore their identities. On the social side, to satisfy audiences demanding representations that feel authentic and do not fall into harmful

stereotyping, studios need to focus on empowering diverse, historically underrepresented, figures to tell stories, especially when those narratives are centered around inherently racialized or cultural issues.

Preliminary Research

Graphics Research

Kim et al. (2021) found 19 graphics publications that claimed to present algorithms that captured the look of “human skin” while only showing renderings of light-skinned humans as evidence of their claim, identifying some of these publications as seminal research in the field. In a similar study, we searched for “skin rendering” in the ACM digital library, with results sorted by relevance. On the top 2 search results pages 16 distinct publications focusing on rendering human skin, both photo realistically and non-photo realistically, were found that included sample renders. Of these, one publication showed a sample render of a dark-skinned character (Peers, 2011). Two other publications displayed sample renders of non-light-skinned characters and people, but these skin tones presented were considerably lighter than the dark tone that human skin is able to take on (Evangelista et al., 2018; Rivier et al., 2020). No publications claimed to exclusively study a particular range of skin tones in their titles, although one claimed to study “diverse skin tones” (Evangelista et al., 2018).

We surveyed publications on hair rendering using a similar method. The phrase “hair rendering” was searched for in the ACM digital library, with results sorted by relevance. The top 25 non-duplicate publications, found on the top 2 search results pages, connected to human hair rendering were analyzed. All publications displayed sample renders of the research presented. One displayed a sample rendering that could be considered visually similar to “type 4” curls that

is often characterized as natural Black coily hair (Ruddock, 2020; Shinya & Nishida, 2014). One publication, focused on braids, displayed styles that are reminiscent of protective Black hairstyles (Zeng, G., & Komura). Other publications displayed mostly straight to slightly waved and textured hair. Some other publications displayed “curly” hair types, but these were not as tightly coiled as the “type 4” curls (Ruddock, 2020). Generally, all publications claimed to study “hair,” that is, there was no explicit focus on straight or curly hair types by publication titles.

Similarly, we surveyed publications on hair simulation as well. The phrase “hair simulation” was searched for in the ACM digital library, with results once again sorted by relevance. On the top 2 search results pages 29 distinct publications focusing on simulating human hair including sample renders were found. Of these, while several had textured and curly hair displayed, none displayed sample images of hair models that could be considered as “type 4 curls” (Ruddock, 2020). Two papers explicitly focused on straight hair (McAdams et al., 2009; Ward, 2010), and one explicitly focused on curly hair (Iben et al., 2013). Notably, while most hair publications also included renderings of human head models, all models were displayed with mid to light skin tones.

Independent Creators

A similar pattern of absence emerges when observing community-driven software packages available for creating humans in animated settings. CGTrader is an online platform where creators buy and sell 3D models for use in animation and game creation in programs such as Blender, Maya, and Unity (“*Human 3D Models*,” n.d.). A survey of the top 120 best matching model packs that are yielded from searching for “human” in CGTrader reveals the following: of these results, approximately 60 showed thumbnail images of human models with a skin tone that could be considered to represent a real skin tone. Results were overwhelming slanted towards

representations of light skin tones. Across these 60 packages, about 88 distinct characters were shown in the thumbnail image, and of these 84 had light or white skin tones while 4 had darker tones. This pattern is not unique to CGTrader; a search for free “human” models on TurboSquid, a similar platform, yields 2 models with a darker skin tone out of approximately 115 distinct models, and a similar bias towards light skin tones is also seen in top results for “human” in the Unity asset store (“*3D Human Models*,” n.d.; “*Unity Asset Store*,” n.d.).

Institutions, Discourses, Representations and Identities

Making Institutions

“Institutionalized ways of knowing things are continually reproduced in new contexts” (Jasanoff, 2004). Social biases rooted in history can be traced throughout the history of animation, beginning with the advent of the camera to modern animation. Animation presents a unique medium in which performers are entirely detached from performances, a phenomenon that early animators were quick to take advantage of (Leslie, 1996). These animators, who were almost exclusively White and male, created and popularized Black and other ethnically-coded characters in early animation. These Black characters generally echoed the pre-established trend of minstrelsy—the stereotypical, caricatured, and typically malignant portrayal of Black characters by White actors—present in live-action western film at the time, re-establishing the institutionalized characterization in a new medium. Characters that continue to be popular in the modern age such as Mickey Mouse originated as animated minstrelsy, though such associations have been obscured over time (Barker, 2010; Roy & Sahharil, 2020). While the offensive nature of some of the humor surrounding these characters was undoubtedly intentional, much of it was a result of the unconscious infusion of internalized bias by the homogenous group of animators,

some of whom did not even realize their choices could be seen as offensive. Only when addressed through education initiated at a studio-wide level was such humor reduced (Roy & Sahharil, 2020).

The overtly offensive nature of such portrayals may have diminished over time, but remnants of the norms that they established remain in the medium, such as the playing of racialized and culturally representative characters by White voice actors. “Whitewashing”—the playing of non-White characters by White actors and actresses—in live-action media has usually been met with widespread criticism in recent years (Levy, 2020). Similar critique leveled at animation studios giving limited ethnic roles to White voice actor is generally more fraught than that aimed at live-action media (Schneider, 2018). This relative ambivalence might be attributed to animation’s niche role in media, but is more likely a result of the animation medium having institutionally been able to treat race and racial significance with ambiguity in a way that live-action is unable to do, with the racial lines of voice acting being blurred in both direction (Barker, 2010). It is understandably difficult to draw the line between post-racial representation and appropriation, but the institutionalization of White voices overshadowing non-White voices cannot be dismissed either, especially when White voices are given to characters that are explicitly characterized and embedded in their non-White culture and experience.

Just as the content of animation developed by following pre-existing standards founded in live-action media, modern computer graphics techniques have been derived from technologies rooted in historical biases. Yale professor and researcher Theodore Kim observed that one of the most highly cited graphics research paper on the topic of human skin focuses on capturing a visual mechanism known as subsurface scattering and only includes sample renders of light skin (Jensen et al. 2001; Kim, 2021). Notably, whereas lighter skin tends to diffuse light more due to

subsurface scattering, darker skin tones are instead characterized by sharper highlights caused by bouncing light (Kim, 2021). Graphics research papers centering the rendering of human skin overwhelmingly highlight lighter skin tones in example renders. Kim notes that, since the widespread adoption and dominance of subsurface scattering in rendering skin, “in graphics when we talk about skin, we’re talking about subsurface scattering that is that dominant visual component of white skin. So, when we talk about skin in graphics we’re talking about white skin” (2021). Thus, it becomes the case that the subconscious social biases that pervaded earlier research was informally institutionalized in the field, and perpetuated by subsequent research.

The bias found at the research stage can also be seen in its applications. Kim refers to sample renders made with MetaHuman Creator, an app created for use with the Unreal Engine game engine to create “high-fidelity digital human” (“*MetaHuman Creator*,” n.d.), observing that the tool seems to have some falloff in quality when comparing renders of Black characters to photos (Kim, 2021). Similarly, in games that have options to create or design playable characters, default options for skin tones generally fail to capture the visual depth, variety, and richness of dark skin tones (Higham, 2022; Parrish, 2022). As found in the preliminary research, software packages that advertise human model packs overwhelmingly display White or pale-skinned characters, and this is seen throughout the animation community. YouTube and Google searches for tutorials on how to 3D model human characters consistently return results that display characters with light or simply unrealistic skin tones, compounding the trend of seeing Whiteness as the norm in these spaces (Kim, 2021).

While such oversights cannot solely be attributed to bias in graphics research—for example, the gaming industry is notorious for its lack of both racial and gender diversity behind the scenes (Wirtz, 2021)—Kim points out that a likely culprit in research is the implicit

assumption that what will work for rendering lighter skin tones will easily and naturally provide a basis for rendering darker tones to equal effect (2021). However, this is not the case. Trying to generalize an approach that primarily utilizes subsurface scattering effects to render skin to darker skin tones can result in poorer representations of those darker tones relative to the lighter ones. While these issues have not wholly prevented the representation of character with non-White hair or skin types in computer generated animated media, it does raise concerns about what the implication is when non-White features are systemically continued to be considered as an afterthought or a deviation from what is thought to be “normal” in graphics research and applications, rather than a phenomenon that deserves a new and unique research approach. Subscribing to the belief that diverse features do not need to be centered at a technological level continues to institutionalize the sidelining and unintentional misrepresentation of such features and stories.

Misrepresentations of people of color by mainly White creators that manifested from the infancy of live-action also came to be institutionalized in animated spaces, and continues to be present in these spaces in altered forms. Similarly, the institutionalized underrepresentation of diverse skin tones in graphics research translates to a similar underrepresentation in applications which reach the public eye, further enforcing a norm of underrepresentation and misrepresentation. Societal values and biases are recreated, institutionalized, and transformed in both the content and the technology of the medium. These values then trickle to the larger public, pushing both the old and shifted values into the cultural narrative and affecting the application of these technologies, as well as the creation of new, similar technologies. Thus, the institutions surrounding the medium provide insight into the way that both society and technology are co-produced.

Making Discourse

The development of discourse, both in terms of language and discussion, surrounding animation and graphics reflects both ingrained biases and potential for change. A study of computer graphics research papers reveals a subtle yet significant pattern of linguistic bias in the field. The language used in the field supports the bias towards Caucasian features described in prior sections (Kim, 2021). Just as the term “skin” in research papers is usually used to exclusively mean “light skin,” contributing to the adoption of an institutionalized norm where in which research on skin has generally centered on fair skin tones, a similar situation arises when discussing hair. Research that claims to focus on simulating and rendering “human hair” more often than not implicitly means “straight hair,” or at most “wavy hair.” Other hair types, such as “curly hair” are then explicitly differentiated. While this phenomenon may be indicative of a pattern in which features that are more commonly associated with people of Caucasian and East Asian descent are placed as the “norm” while other features are shunted out and differentiated, this also could be attributed to curly hair being more technically complex to simulate than straight hair (Bertails et al., 2006; Iben et al., 2013; Kim et al., 2021). However, even within this differentiated group there is a lack of diverse representation. Papers on “curly hair” rarely, if ever, encompass the full range of curly hair types—such as the tight curls characteristic of some African hair types—or show example renders of non-White characters (Kim, 2021).

In a talk at the 2021 SIGGRAPH (Special Interest Group on Computer Graphics and Interactive Techniques) conference, Kim points out that textures similar to those characteristic of kinky African hair types are in fact being researched and simulated. However, Kim notes that, intriguingly, these simulated materials are not labeled as hair (2021). Jiang et al. (2016), a research paper detailing a method’s effectiveness for simulating a variety of textures, noticeably

has a section and image associated with “hair” which depicts straight multicolored strands, yet places a render of material that is evocative of kinky African hair types outside of this section labeling it instead as “fibrous material”. As Kim states, “the idea that this [fibrous material] could also count as hair is not in [graphics researchers’] technical vocabulary” (Kim, 2021). The way in which the technical language surrounding the field has grown perpetuates existing biases.

This unconscious sidelining of non-Caucasian features has not precluded demands for racially diverse animated media, however. This demand is evident in the discourse surrounding the medium, both in response to newer creations and in modern reflections on older pieces (Ellis, 2017). To cater to the increased demands for representation from an increasingly globalized audience, large animation studios, notably Disney, have been making attempts to tell more racially and ethnically diverse stories since the 1990s, to varying effect (Barker, 2010).

Shifts in discourse surrounding such pieces of popular animated media are indicative of evolutions in societal expectations and values over the years. Author and YouTuber Lindsay Ellis (2017) notes the similarities in plot structure of the Disney movies *Pocahontas* (1995) and *Moana* (2016), which both star young indigenous women, while analyzing the differences in the receptions of these films from members of the represented, and often marginalized, communities. Even closely following its release, *Pocahontas* was received critically by members of indigenous communities and critics alike, with the protagonist’s characterization and design often criticized as perpetuating stereotypes of indigenous culture (Sardar, 1996).

Ellis describes the 1995 film as “a mistake”, citing its many missteps in regards to representation and treatment of the historical events it was based on, but argues that *Moana* (2017), a “soft remake” of the 1995 movie, as well as responses to *Moana*, provides insight into the evolving narrative regarding representation in animation as a whole. Unlike its predecessor,

reviews for *Moana* tended to be more ambivalent, with both praise for some aspects of the cultural representation and criticism for other more stereotypical features of the film (Ellis, 2017; Grandinetti 2017). Ellis remarks that this shift in discourse gives her hope, noting that she “feel[s] like we’re making progress from the days of Pocahontas. It’s no longer a hot mess but a mixed bag,” while also remaining critical of the fact that despite the attention the creators of the 2016 movie paid to cultural accuracy, even forming a cultural trust of advisors, there is still much progress to be made (2017). In reference to *Moana* being directed by two White men, even as he recognizes positive aspects of the film’s representation and message, Doug Herman, a Smithsonian scholar writes “Having brown advisers doesn’t make it a brown story. It’s still very much a white person’s story,” (Herman, 2016).

The technical language of the medium, rooted in societal norms, continues to affect the further development and perception of the technology in the current day. In this sense, discourse reveals the ways in which societal biases are sustained over time in and by technology. At the same time, discourse surrounding the animated medium reflects how societal values and demands have shifted over time and similar discourses surrounding graphics technology give a glimpse into the possibility of these shifting views in turn affecting future technological developments.

Making Representations

As a medium unrestricted by physical laws, creating new forms of representation is naturally at the heart of animation. However, while animated characters throughout the years have moved unconstrained by natural laws, they still reflect, and are perhaps constrained by, the values of the societies they were created in. Just as early animation gave rise to a new form of minstrels, the separation between the creator’s identity and the identities they could create and

portray in animation similarly allowed for characters to be brought to the screen that appeared to be intrinsically “raceless”. Often anthropomorphic, these characters, however, were far from raceless (Lugo-Lugo & Bloodsworth-Lugo, 2009). Instead, the medium’s ability to blur racial lines actually allowed for pre-existing racial and ethnic stereotypes to manifest in a more covert way (Gateward, 2000). The 1993 stop-motion animated movie musical *The Nightmare Before Christmas* features a cast of fantastical characters with no obvious racial coding apart from the film’s antagonist, who is given a distinctly Black speech pattern and dialect, as well as a Jazz-influenced musical number (Gateward, 2000). Several of Disney animation’s earlier films lend blatantly stereotypical negative traits to racially coded characters, from the poor, unintelligent crows in *Dumbo* (1941) portrayed with Black speech patterns to the menacing, slanting-eyed Siamese cats in *Lady and the Tramp* (1955) who sing in broken accents and are given names evocative of East Asian surnames (Towbin et al., 2008). Disney’s *The Lion King* (1994), set in Africa, ostensibly carries a message about inclusion and harmony while also featuring a cast of hyena characters, characterized as outlaws and criminals, who speak with Black vocal inflections and slang, while the rest of the cast speaks “proper” English (Gateward, 2000). Even when the racialization of non-human characters is more benign, such as in Dreamwork’s *Shark Tale* (2004), it is evident that animation provides a unique means of creating racial representations in a way that is perhaps more veiled than in live-action media (Lugo-Lugo & Bloodsworth-Lugo, 2009).

At the same time as allowing for hidden racial messaging, this blurring of racial lines also provides a way to obscure and avoid race when chances for positive representation arise. Disney’s *The Princess and the Frog* (2008) was highly anticipated for introducing Tiana, the first Black Disney princess, but faced criticism when it was realized that Tiana spent the majority

of her film transformed into a frog (Golding, 2021; Tejada, 2020). As such, *The Princess and the Frog* explored a highly racialized setting—1920s New Orleans—with a supposedly Black character while avoiding the deeper problematic implications of such a setup (Kern, 2021). While it can be argued that portraying race relations in 1920s America was not the point of the movie, a whimsical fairy tale, the fact remains that *The Princess and the Frog* is not an isolated case. In an affliction that their White counterparts appear to be immune to, characters of color are transformed into non-humans in animated films from Disney's *The Emperor's New Groove* (2000) and *Brother Bear* (2003) to Dreamwork's *Spies in Disguise* (2019) to Pixar's *Soul* (2020), the first Pixar movie to center a Black character. While it cannot always be claimed that such transformations are unwarranted or unnecessary to the story that is being told, it does give reason to question why these transformations are limited to characters of color, and in what ways such representation allows for the erasure and avoidance of race (King et al., 2010; Tejada, 2020).

Animation technology also gives way to new forms of cultural appropriation. The 2006 film *Happy Feet* utilized motion capture technology to tell the story of a tap-dancing animated penguin (Allison, 2015). While the main protagonist was voiced by Elijah Wood, a White American actor, the physical performance of the character was created by Savion Glover, a renowned Black tap dancer. The dance performance is integral to the film's story, yet Glover is hardly recognized in any of the marketing or titles of the movie. Glover's performance, rooted in Black dance culture, is obscured by the film's marketing and the anthropomorphic, seemingly raceless nature of the character. While this de-racialization of the protagonist might be seen as a symbol of post-racial representation and the harmonious melding of performances, author and Emory College professor Tanine Allison observes that in the context of the film and its other problematic representations of racially coded characters, this de-racialization is instead

emblematic of racial appropriation (2015). The technology, as well as the way the different players surrounding the technology are treated, thus reveals the way that technological and societal developments are inherently linked, through showing how a truly de-racialized representation of the world is nearly impossible to create within a racialized societal context.

Making Identities

Jasanoff describes identities as “one of the most potent resources with which people restore sense out of disorder” (Jasanoff, 2004, p. 39). Through representations animated media defines and redefines cultural and racial identities. Beginning from who gets to be represented in this medium to the quality of these representation, animated storytelling shapes perceptions of the self, the cultural group that one belongs in, and other groups (Brooks & Hébert, 2006).

In an article addressing the trends and role of television content in shaping and representing society, Gerbner and Gross assert that “Representation in the fictional world signifies social existence; absence means symbolic annihilation” (1976). Prior to analyzing the role of the quality of representation, the question of what groups get to be represented must be considered, with some going as far as to claim that “any kind of representation, no matter good or bad is better than none” (Roy & Sahharil, 2020). While diversity has been increasing in some mainstream media, such as blockbuster animated movies (Smith et al., 2018), there is still a dearth of readily available diverse representation in the behind-the-scenes graphics research and independent creator spheres as demonstrated by the surveys conducted in this study.

Animated media, as non-literal representation of the world provides a space to create, express, and explore new identities (Silvio, 2010). Stop-motion animation has been found as a useful tool in arts education, allowing for students to study and express themselves in a new format (Blair, 2014). Forms of media that involve “active” consumption, such as games that

allow for users to customize their own avatars, also exemplify this. Therefore, such a lack of representation both symbolically erases the existence of diverse perspectives while also causing difficulties for those who identify with and wish to tell stories through these perspectives, implicitly discouraging the participation of members of these marginalized groups (Fryberg & Stephens, 2010; Gerbner & Gross, 1976). Video game players who are unable to identify with the character they play as feel less immersion and have less enjoyment of gameplay (Passmore et al., 2017). Unlike their more commonly represented White counterparts, creators of color are often forced to take extra steps if they wish to be able to even partially represent their own identities and narratives (Parrish, 2022).

Once representations have been established, attention shifts to the quality of representations. Adding diverse representation must go far deeper than simply including greater ranges of characters skin tones or hair types to feel authentic to consumers. Passmore et al. (2017) recognizes that simply changing, for example, a White character's visual presentation to a Black character fails to authentically represent identity, and is no more than "high tech Blackface" (p. 145). Such an identity should likely also herald changes in speech pattern, behavior, and style, as identities are inherently rooted in culture and historical context. However, in order to represent these cultures without falling into pitfalls of stereotype, it becomes increasingly important to include members of the community being represented. Otherwise "Without conscious attention to the diversity of these details, White developers create characters of color from what they know and players of color perceive this underlying Anglo-identity" and consumers of color are repeatedly underserved in terms of opportunity to explore identity (Passmore et al., 2017, p. 144).

Quality of representation is also crucial to the formation of identity especially for young children, which much of mainstream animated media is geared towards. This is particularly for members of historically marginalized and underrepresented social groups (Brooks & Hébert, 2006; Schmader, 2015). Members of disadvantaged minority groups have been found to feel greater negative emotions such as embarrassment towards their own ethnic identity than members of majority groups did when shown negative or stereotypical portrayals of their own social groups (Schmader, 2015). Media representation is also vital to the formation of a sense of cultural identity, especially for members who do not have many opportunities to strengthen those identities in their daily experiences. For instance, young Native American girls from urban areas placed greater importance and relatability on *Pocahontas* (1995) than Native American girls from rural reservations (Aidman, 1999).

Therefore, it is critical for media creators to not only increase diversity in terms of numbers, but also ensure that the added representation does not carry with it harmful stereotypes and biases (Erigha, 2015; Passmore et al., 2017). In order for these diverse stories to be told authentically, it is important for members of the represented group to have a role in the creation of these representation, as they can provide insights into the represented culture, community, and identity that others do not have experience with (Brown, 2020).

Limitations

At the current time, there is no standard model of comparison that graphics researchers can use to test the visual fidelity of their creations, so even if there is a falloff in quality for the visual representation of certain traits, it is difficult to quantify this discrepancy (Kim, 2021). As such, the problem at the heart of this paper – racial biases in graphics and animation technology

– is difficult to quantify. Additionally, a fully informed survey of graphics literature was not conducted, as our preliminary study solely focused on top results found in the ACM digital library with limited search phrases, which is likely not completely representative of the state of current literature. A more holistic approach may be possible with researchers who have more extensive knowledge of what pieces of graphics literature are considered to be seminal to the field at large.

Furthermore, this study mostly focuses on western animation, and within that sphere, as a whole centers western feature-length animated film from larger studios. Studies with a more globalized view of animation might reveal ways in which non-western studios are also influenced by the biases present in western animation and technology, or they may reveal practices that reflect or contest their own societal biases. Studies of broader animated content, such as television shows might be able to provide deeper insights into shifts in culture surrounding animation and representation in animation, notably, so-called “adult animation” is often more willing to directly provide social commentary. Studies of less formal independently-created animated content as found on platforms such as YouTube may also be able to provide key insight into how the field of animation is developing as a result of technological developments giving small-scale creators power over their own narratives.

Future Research Directions

Continuations of this work might strive to both identify more ways in which bias permeates current graphics technology and animation culture and strive to address these biases. Also suggested by Kim (2021) and Kim et al. (2021), research into creating more definitive benchmarks for graphics research, especially concerning human traits like skin rendering and

hair dynamics simulation, would be beneficial in holding researchers accountable for considering and accurately representing diverse features. Identifying more instances of how historical biases have affected discourse and technological language is also necessary to create an equitable research environment. Future work may also concern more social aspects of the issue at hand, such as studying the effectiveness of methods that are meant to increase diversity in the animation industry such as diversity initiatives and online resources aimed specifically at creators from marginalized groups. Future directions of similar research may also begin to analyze biases from graphics and animation that could be carried into the technology used in augmented reality (AR) and virtual reality (VR) spaces, which are becoming progressively more common in recent years and arguably attempt to provide even greater immersive experiences for users (Ramirez, 2020).

Conclusion

As diverse audiences grow more aware of the impact of representation in media at both personal and societal levels, consumers continue to seek out authenticity and “good” representation in the media they consume (Ellis, 2017). However, evidence of racial bias is found throughout the history of animated media, and issues of misrepresentation and appropriation continue into the current day. Moreover, implicit biases are embedded into animation and graphics technology, from the research stage to applications, providing additional obstacles for creators who wish to tell diverse stories using the medium. While advances in computing technology and the availability of graphics tools to the public have given smaller studios and independent creators more ability to tell their own stories, the amount of technology, manpower, and money needed to create animated media that meets modern visual expectations

means that generally larger studios continue to dominate the industry (Passmore et al., 2017; Benshoff & Griffin, 2004). In order for large corporations to meet this demand for authentic storytelling without falling into common pitfalls of stereotype or tokenizing, diverse voices need to be uplifted and given the creative power to helm their own projects.

On the technological side, clearer standards and expectations for graphical simulation and rendering of humans should be established to better ensure that the field is developed in ways that actively include and accurately represent diverse features. Further research into the presence and identification of implicit bias in the field of computer graphics and animation technology must be carried out, and researchers and creators alike should be educated to recognize and address these biases.

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