

Undergraduate Thesis Prospectus

**Non-Photorealistic Path Tracing:  
Rendering in the Style of Studio Ghibli**

(technical research project in Computer Science)

**Changing the Landscape: Making  
Creative Teams More Diverse**

(sociotechnical research project)

by

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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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## **General Research Problem**

*How can the types of stories told in popular media be diversified?*

Media, online and off, influences thoughts, feelings, and actions. Creative teams that are exclusive and unrepresentative tend to produce stories that overlook or caricature diverse cultures (Wolpert, 2020). According to Leahy and Foley (2018), the omission of diverse characters and ideas from the books that children and young adults read “sends subliminal messages about what is acceptable and what is ‘the norm.’” Among media audiences, many are demanding more diverse characters and storytelling. Yalda Uhls, an adjunct professor of psychology at UCLA, warns that without a broader range of voices, “stories and characters will come across as stereotypical” to the modern audience (Wolpert, 2020).

By empowering diverse creatives early in the process, providing them with physical tools and resources to succeed, advocates of reform can promote the change they seek. When a wide range of people contribute to storytelling and learn the trade, they can promote a more inclusive media future (ASWF, 2020). Advocates of change can compel media companies to recognize talent working behind the scenes and to cast a “wider net for hiring,” thereby fostering a more inclusive pool of storytellers (Wolpert, 2020).

## **Non-Photorealistic Path Tracing: Rendering in the Style of Studio Ghibli**

*How can non-photorealistic methods and path tracing be combined to render scenes in Studio Ghibli’s style?*

This is a capstone research project in Computer Science. The technical advisor is Luther Tychonievich from the Department of Computer Science. Other student collaborators include Nicholas Moon.

## *Project Overview*

Path tracing is a computer graphics method for rendering, the process of creating images from models. The algorithm can simulate many complex effects, such as caustics, soft shadows, and motion blur, making some images indistinguishable from reality. Photorealism is often the focus of computer graphics research; however, many artists believe that graphics should “facilitate interpretation” and aid in the “symbolization of the world” achieved by traditional art (Yoshinori, 1999). Non-photorealistic rendering (NPR) techniques, such as cartoon and painterly rendering, are able to articulate this sentiment. Although these techniques are rarely paired with path tracing, both engineers and artists are beginning to see the value of their combination. The fusion of techniques offers opportunities for storytellers to express their unique vision and style (Sisson, 2020).

Project goals include building a path tracing algorithm that can effectively incorporate non-photorealistic methods, with Studio Ghibli’s style as a target. Ghibli films generally include hand-painted backgrounds and toon-shaded foreground objects. Another goal is to make the final product accessible, well-documented, and easy-to-use by artists. This will be achieved by integrating it into an open-source 3D program or renderer.

Constraints include limited flexibility with existing open-source code. Several open-source renderers have plugins to common 3D programs like Maya and Blender, but complicated file structure and formatting make them difficult to adapt to the project’s needs. Another constraint is limited rendering power, making candidate programs limited to those that can run efficiently on a standard laptop. This also eliminates possibilities for optimization techniques that require more powerful computing resources or GPU parallelism.

### *State of the Art*

Most modern graphics applications and renderers, such as Maya, V-Ray, Arnold, and RenderMan, are capable of generating photorealistic images, but include little support for non-photorealism. NPR styles are applied at the shader or material level, but are not traditionally done during the rendering process. For example, V-Ray and Arnold use toon shaders and filters to replicate a cartoon look (Chaos Group, n.d.; Arnold, n.d.). Most painterly looks are achieved during post-processing by filtering a rendered image and painting based on color differences (Hertzmann, 1998). This leaves room to determine how to best utilize advancements in computer graphics, such as path tracing, without compromising artistic style. For easier integration into a 3D program, we are investigating LuxCore, a physically-based renderer with path tracing and plugin support. Support for non-photorealistic styles would need to be added into the code.

### *Methodology and Future Work*

Using self-developed cores for rasterization and ray tracing, we plan to build a prototype of the final system that utilizes Ghibli's painterly and toon styles. This enables quick testing of NPR algorithms and gives us greater flexibility to modify the code to suit our needs. After refining the style algorithms, we plan to integrate them into an open-source path tracer for the final deliverable.

A successful project will produce a path tracer that renders 3D scenes in Ghibli's style, preferably in a format that can be integrated into Maya or Blender. If this style can be successfully achieved, then it is possible to extend the project to accommodate any artist's preferences.

## **Changing the Landscape: Making Creative Teams More Diverse**

*How are the animation and computer graphics communities working to enhance diversity in the creative process?*

Their mass audiences make studio giants such as Disney, Pixar, and DreamWorks culturally influential. According to Sandlin and Garlen (2017), Disney and other sources of cultural influence shape conceptions of “gender, sexuality, race, class, ethnicity, and childhood.” Because many children and young adults respond to onscreen characters, disparaging portrayals or omissions of characters like them may diminish their self-esteem (Dobrow et al., 2018).

According to the Computing Research Association (CRA), diversity is an advantage on teams; when the team has diverse ways to “perceive and solve problems,” it is less likely to “miss a critical perspective” (2017). Edmondson and Roloff (2009) contend that teams need “psychological safety,” or “a climate in which people feel free to express work-relevant thoughts and feelings.” Inclusivity fosters psychological safety by preventing team members from perceiving that they belong to an outgroup.

### *Related Studies*

In animation and computer graphics, workplace diversity is poor. Tsui (2007) reviews common inclusion strategies, including mentoring, career counseling, workshops, seminars, and curriculum reform. Smith et al. (2018) note that in film, inclusion riders, target inclusion goals, and policy reform can promote enduring change.

Researchers have highlighted contributing factors to effective strategies. According to Lewis et al. (2019), cultural change is important and possible. When workplaces meet underrepresented groups’ “varying levels of communal values,” promote interaction between different groups, educate employees about institutional biases, and use language sensitive to

everyone's needs, they can foster a sense of belonging. Similarly, Smith et al. (2019) note that female animators often lack a sense of belonging in a male-dominated workplace culture, and suggest that community-building and camaraderie are important to their careers. Tsui (2007) adds that many underrepresented groups do well under initiatives that emphasize "real-life applications" and community contributions.

### *Major Participants*

At its annual conferences, ACM SIGGRAPH promotes "awareness, education and resources," releasing over 250 hours of content that it claims builds "cultural awareness, knowledge, and educational enrichment for members" (2020). The Academy Software Foundation (ASWF) promotes opensource development in the animation and VFX communities, striving to "break down racial, gender, and corporate barriers to unite people around a shared goal" (ASWF, 2020). Reformers' targets include the established institutions they associate with the status quo, including the Academy of Motion Picture Arts and Sciences (AMPAS). AMPAS has responded to the pressure, announcing new inclusion criteria for its Oscars nomination process. It hopes that the standards will "better reflect the diversity of the movie-going audience" (2020). Women in Animation (WIA) is an advocacy group that seeks to "expand and diversify the talent pool of storytellers and artists." WIA pursues gender parity in animation through mentorship, workshops, and seminars (Tsui, 2007; WIA, n.d.). Animation and graphics fans organize through social media to promote diversity in films, share links to advocacy groups, and voice their opinions about current content (Magaña, 2019; Juwono, 2020). Some animation companies want to increase their appeal and profitability among a varied audience by recruiting diverse creatives. Pixar's president, Jim Morris, argues that "it is essential that our own team represents the whole of that audience...and hopefully allows everyone who goes to see a Pixar

movie to see a bit of themselves on the screen” (Pixar, n.d.). The Universal and DreamWorks Global Talent Development & Inclusion department claims it aims to tell stories with “inclusive narratives that reflect the global audience” (Universal, n.d.).

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