Thesis Project Portfolio

3D Modeling in Unity: Utilizing Algorithms and Digital Models to Reinvent Sports Analysis

(Technical Report)

Digital Artifacts: A Museum's Best Underutilized Resource and How Museums May Best Take Advantage of Them

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Sciences

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Brandon Nielsen

Spring, 2022

Department of Computer Science

Table of Contents

Sociotechnical Synthesis

3D Models: Exploring Their Usage as a Sports Analysis Tool and as Museum Artifacts

"The improvements I made through over the last ten swings, with the 3D analysis, would have taken me months to achieve." This is a quote from a professional golfer who utilized my company's motion capture suits after we developed animated 3D models for sports analysis. 3D models are a relatively new and innovative technology, utilized to create visuals of objects and scenes previously out of reach. This technology has proven to provide a deep, technical level of analysis to the objects being modeled. Furthermore, this new ability to render and create models allows for a better understanding of ourselves, our history, and our world. My research has focused on engaging myself in 3D modeling technology and analyzed its benefits/limitations. My technical project centered around developing an animated 3D model of a human for a sports analysis company and integrating said model with their current motion-capture technology; while my STS research focused on how digital artifacts, such as 3D models, may be revolutionizing the way museums prepare exhibits.

My technical project focused on developing 3D models for a motion-capture, sports technology company. The company builds motion capture suits, which it uses to analyze an athlete's movements, such as a baseball or golf swing. While their suits were successful in gathering a large amount of the athlete's motion data, athletes were finding it difficult to improve themselves by only looking at charts/graphs. In order to solve this problem, the company decided that it would best benefit from implementing a 3D model of a human, then animate that model based on the movement data of an athlete. The first step for designing the model was to decide on the development platform and the Unity game engine was chosen for its compatibility with

the company's app and its built-in physics engine. Next, a human model was chosen and integrated into the Unity environment. Finally, the model was animated by parsing the motion data lists created by the motion capture suits. Position data and translational functions were created to move each of the limbs of the body based off of individual sensors. The model was a success in animating the movements of an athlete and it became one of the company's most useful tools for sports analytics.

The STS research I conducted focused on the impact of "digital artifacts" on museums and how they may become essential assets for museum exhibits. Digital artifacts are representations of physical objects created through digital means, such as 3D models, images, or scans. The research starts by analyzing the extent to which museums currently utilize digital artifacts. A literature review and analysis of museum exhibits was conducted to determine how digital artifacts are incorporated into the museums. In addition to understanding how digital artifacts are currently utilized, this research also examines the sociotechnical structures within the museum system that may inhibit the progress of digital artifact integration. The research concludes by making suggestions for how museums may better use the digital artifacts at their fingertips, such as creating public databases.

The research conducted in my STS and technical projects help grant an understanding of both how to create 3D models and their significance in society. The technical project imparts an understanding of how these models are created, their implementation, and their integration into a company's product line. It teaches how 3D models are an extremely effective tool in analyzing physical objects. On the other hand, my STS research examines how these 3D models, as well as other digital artifacts are underutilized tools in some areas of study. Specifically, the STS research analyzes museums and how they are a detailed socio-technical system which hasn't

fully integrated 3D models into their paradigm. This fusion of technical analysis and the examination of how said technology may be integrated into society is the ultimate purpose of this project.