DESIGNING A 3D PLATFORM FOR BEGINNERS AND CHILDERN

EXAMINING ACTOR INTERACTIONS TO SIMPLIFY 3D SOFTWARE FOR NOVICE USERS AND CHILDREN

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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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I. Introduction

The ability to create 3D models and animate them using a computer has attracted both adults and children. However, due to the complex and overgeneralized nature of current 3D platforms like AutoCAD, Blender, and FreeCAD, these tools are not optimally designed for children and beginners. When asked to describe Blender's interface, novices found it overloaded, confusing, and overwhelming (Mosiiuk et al., 2023). Additionally, CAD software often suffers from a "spaghetti interface" overloaded with commands, which can intimidate beginners (Szewczyk & Jakimowicz, n.d.). To encourage novices and children to learn 3D modeling and animation, there is a need for a 3D platform designed specifically for beginners.

Most 3D platforms focus on task-generality that are "designed to work in any task situation," without targeting specific beginner-friendly tasks (Bowman et al., 2006). This can limit novices from completing basic tasks, such as object creation or simple animations. My proposed platform will address these issues by specifying both the target users, beginners and children, and the achievable tasks. Users will be able to create simple and predefined scenes with 3D models and animations. Each scene, such as a car stopping at a red light, will include a preview, to help users see the result. A guided step-by-step approach will simplify each scene and users will receive prompts after completion to encourage creativity.

I will use Tinkercad as a case study to understand the challenges in designing accessible 3D modeling tools. Tinkercad was developed as a beginner-friendly platform, however, Tinkercad's design lacks features such as collaborative learning and intuitive spatial navigation. I will investigate how elements such as interface design, user interactions, and collaborative tools

impact usability and learning outcomes using Actor-Network Theory. Young and novice users frequently struggle with Tinkercad's spatial tasks, like perspective-changing and model alignment, and addressing these usability gaps is crucial. Without improvements, Tinkercad and similar platforms risk discouraging beginners and limiting their understanding of basic 3D concepts.

Because the challenge of making 3D modeling accessible for young and novice users is sociotechnical in nature, it requires attending to both its technical and social aspects to accomplish successfully. In what follows, I set out two related research proposals: a technical project proposal for developing an improved 3D animation platform tailored for beginners, and an STS project proposal that uses Tinkercad as a case study to examine how limitations in design and collaborative features impact user engagement and learning in 3D modeling.

II. Technical Proposal

Interest in 3D modeling and animation for both educational and creative purposes has grown rapidly. However, existing platforms, such as AutoCAD, Blender, and FreeCAD, are too complex for children and novice users due to their overloaded interfaces and overgeneralized approach to task design. The lack of specificity and clarity in such platforms can result in frustration and discouragement for beginners. I aim to design an intuitive 3D animation platform specifically for young learners and beginners that is focused on guided goal-oriented learning.

Most 3D modeling platforms follow the WIMP (Windows-Icon-Menu-Pointer) interface model, which is effective for professionals but overwhelming for novices because of the large number of commands and options available (Szewczyk & Jakimowicz, n.d.). Platforms like Blender and AutoCAD have hundreds of commands that create a "spaghetti interface" effect

where users struggle to find relevant tools and understand icon meaning (Szewczyk & Jakimowicz, n.d.). Additionally, current platforms lack motivational features that could help encourage exploration and engagement in the learning process.

Some 3D platforms attempt to simplify the learning curve through instructional videos or tutorials; however, they do not address specific needs for hands-on and task-oriented guidance. For example, watching YouTube tutorials helps beginners to follow along with experts, but this approach lacks interactivity. Users cannot directly ask questions or receive real-time guidance. A beginner 3D platform user noted that while watching YouTube tutorials, novices struggle with version differences, shortcuts, or functions they may not understand. The platform I propose will allow for guided learning and provide users with step-by-step assistance, which will reduce the need to pause, rewind, or navigate differences in software versions (Chilana et al., 2018).

Novices also struggle with specific spatial tasks such as perspective-changing, model alignment, and mental rotation. Failure to understand these concepts can make traditional 3D modeling platforms even more challenging for beginners (Bhaduri et al., 2021). The platform will address these issues by incorporating design principles that focus on learnability. Using Grossman et al.'s survey on software learnability, this platform will use a question-suggestion protocol to evaluate learnability during development to ensure it meets the needs of beginners (Grossman et al., 2009).

The platform I propose provides practical benefits over existing designs. The platform will focus on predefined and guided scenes where beginners can experience a more structured learning journey. Each scene will include a preview (e.g., a car stopping at a red light) to allow users to see a clear goal and be encouraged. Following the guided completion of each scene,

users will be presented with a creative "prompt" related to what they just learned, encouraging them to apply their skills and explore different outcomes. This approach supports both learning and confidence-building by allowing learners to create without the overwhelming complexity of traditional 3D software.

To improve the platform’s accessibility, I propose a gesture-based animation interface, inspired by Mokhtar's investigation into intuitive interaction. This interface will allow animators to control 3D characters in real-time through physical gestures and bypassing the reliance on indirect mouse or keyboard manipulation. Direct manipulation through body movements will reduce production time, improve movement accuracy, and deepen the user's connection to the model. This approach could lower the learning curve and make animation feel more natural and responsive, especially for beginners who may find GUI/WIMP systems unintuitive (Mohd Mokhtar, 2017).

The platform's development will use several engineering principles, including human-computer interaction design, heuristics and usability frameworks from Norman’s design principles and Nielsen's usability heuristics (Lee-Remond et al., 2024). These frameworks will guide interface decisions to make it clearer and learnable. Additionally, drawing insights from MarmalAid’s approach to real-time, in-context help, our platform will allow users to see clear visual feedback and receive task-specific guidance (Chilana et al., 2018).

The platform’s initial design data will be collected from usability studies from other novice-oriented platforms. I will also use observational studies to collect data on user interactions with the interface and to improve the design iteratively. Finally, the platform's effectiveness will be tested through controlled user studies. These studies will focus on task completion time, user

satisfaction, and skill retention, which will validate the platform's suitability for the target audience.

III. STS Proposal

In recent years, 3D modeling platforms like Tinkercad have come out as valuable educational tools that encourage creativity and computational thinking for students. Tinkercad is a browser-based platform that allows students to create 3D designs that educators can use to teach STEM concepts through hands-on learning. However, Tinkercad faces significant challenges in effective classroom use, especially for novice users who struggle with spatial thinking and the platform's limited design options (Mosiiuk et al., 2023). Tinkercad includes features designed to simplify 3D modeling, like pre-made shapes and a basic interface; however, these benefits did not translate to classroom success. Educators noted that students often face obstacles with perspective changes, mental rotation, and interface navigation (Bhaduri et al., 2021).

Educators play an important role in Tinkercad's classroom adoption, since their teaching approaches impact its effectiveness. Research shows that educators require additional training and support to effectively help students, especially those struggling with basic spatial skills (Deniz & Eryilmaz, 2021). The experience of students with Tinkercad can become frustrating without the support of educators, especially those who have difficulty understanding 3D spaces or rely on educators to overcome obstacles. Because of this, there are challenges in integrating Tinkercad in educational environments.

Dynamic visualization can improve STEM learning by helping students understand complex concepts through tools like animations and 3D models. This helps cognitive processing by presenting continuous representations and reducing cognitive load (Teplá et al., 2022). However,

research shows that its effectiveness varies depending on factors such as subject matter, student age, gender, and teacher characteristics; this shows the importance of specific instructional strategies for using visual aids in the classroom.

I will apply actor-network theory to analyze Tinkercad's usage in the classroom. Actor-network theory shows technical projects as networks made of heterogeneous actors, human and non-human, that work together to achieve a goal (Law, 1992). These networks require continuous efforts of translation, to align actors and maintain cooperation. Translation in this context involves aligning the goals of designers, educators, and students while anticipating resistance and adaptation in the network (Cressman, 2009). Durable materials, such as Tinkercad's interface and pre-designed tools, play a key role in stabilizing the network by incorporating relational patterns that support usability and learning over time. However, these materials are influenced by relational dynamics, as educators' teaching methods and students' varying spatial skills impact how effectively the platform functions in different settings. Additionally, the platform's ability to work across contexts depends on its "mobility," or how its design can make learning easier in diverse classroom environments to guarantee that elements like visual aids and teacher support remain effective regardless of location (Law, 1992).

Previous research addresses these social factors in educational technology, but a complexity arises from the conflicting goals of Tinkercad's designers, educators, and students. Designers prioritize simplicity to enhance accessibility, but this often limits advanced design capabilities, which may frustrate skilled students and complicate educators' efforts to meet diverse needs. Actor-Network Theory helps with understanding these challenges through the concept of translation, which involves aligning the interests and actions of all actors, students, educators,

and the platform, into a cohesive network. According to Law (1992), translation is a process that requires continuous negotiation and adaptation to maintain stability and order within the socio-technical network.

In Tinkercad's case, failures in translation happen when actors' needs are misaligned: educators often lack the training and resources to effectively teach spatial skills, and the platform's simplicity may not support advanced learners. These gaps create resistance within the network, which destabilizes its structure and limits its effectiveness in classrooms. Translation also involves managing the relational effects of power and resistance. This highlights how the interactions between actors shape the network's strength. Addressing these challenges requires strategies that anticipate the different needs of actors, to ensure that Tinkercad functions as a durable and adaptable educational tool. This approach will assist the network to achieve greater alignment and improve its integration and effectiveness in classroom environments.

To support my analysis, I will use qualitative sources, like educator interviews, surveys, and video analyses of students using Tinkercad. In addition, I will examine case studies on Tinkercad's classroom implementation and research on young learners' spatial skills. These sources underscore the importance of support in navigating Tinkercad's interface challenges and helping students with spatial difficulties (Deniz & Eryilmaz, 2021). Through this analysis, I plan to demonstrate how the combination of user experience, educator guidance, and interface design impact Tinkercad's capability and propose ways to strengthen these networks for better educational outcomes.

IV. Conclusion

This proposal addresses the challenge of making 3D modeling accessible to beginners by creating a specific platform for young learners and novices. It also analyzes existing limitations in tools like Tinkercad. In the technical project, I propose a beginner-friendly 3D animation platform with guided and task-oriented learning to reduce complexity and improve usability for novice users. The STS research uses Actor-Network Theory, particularly the concept of translation, to understand how interactions between designers, educators, and students shape Tinkercad's classroom effectiveness. It specifically focuses on identifying social factors that affect usability and how aligning these actors' goals can improve the platform's stability and usability. I will use observations from the STS proposal, like the importance of educators' guidance, to modify the technical design to meet user needs. Both projects plan to provide a solution that highlights both technical and social obstacles that affect 3D modeling for education, which will help create a more inclusive and supportive learning environment for beginners.

Word Count: 1989

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