Digital Sculpting In VR,
An Insight Into An Alternative Medium

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1. Introduction

In the modern day of computing power, most productive activities are done in front of a desktop computer setting. We have grown accustomed to navigating and working with the combination of mouse and keyboard as main navigation tools, and they have proven to be incredibly useful. However, there is a clear disadvantage in navigation when it comes to three dimensional (3D) interactions. Depth perception is difficult, navigating a 3D space with 2D cursor interactions can be unintuitive (*Kukreja et al.* [4]). A lot of these limitations have been partly mitigated with technologies in Virtual Reality (VR). Despite this, it is still not very widely commercialized and adopted by many people. This can be traced to the lack of demands and cost , as well as the complexity of the setup procedures usually needed for these kinds of interaction. In this study, we focus on the potential impact of incorporating VR with digital 3D modelling, specifically digital sculpting. We seek to understand the advantages and disadvantages for 3D interaction in VR compared to standard desktop setup in a few scenarios. Firstly is navigation in the viewport 3D space, secondly we look into the basic manipulations of objects. Finally, we asked the participant to perform a combination of these basic tasks to attempt a basic sculpture that highlights the differences between the two types of interaction for digital creation.

Our experiments provide several insights into the differences between traditional desktop setups and VR setups for digital 3D sculpting. By comparing navigation, object transformation, and actual sculpting tasks, we identified how VR sculpting excels in certain areas, such as allowing more fluent and organic movements and shapes, while also recognizing its limitations, including setup complexity and precision challenges. The results help clarify the contexts in which VR sculpting can be more effective than standard setup, such as creative and global shape, where our keyboard and mouse are still more suited for more precise and detailed sculpting.

2. Related Works

Some studies have investigated the benefits of using VR rather than the traditional keyboard and mouse to interact with 3D softwares. Unfortunately, they are still few, because of the early development of this technology (compared to the keyboard and the mouse), and the difficulty of accessing it for price and setup reasons, as said before. Moreover, most of those studies focus on modelling and not on sculpting. In fact, the state of the art is still in the process of solving more fundamental problems related to VR interactions in general, rather than problems related to 3D artistic or industrial creation using VR.

2.1. Sculpting in mixed reality

Sculpting with a mixed reality setup has been introduced by the tool Virtutello (*Van Der Kroon et al.* [2]). Despite the difference in the technologies used in their study (mixed reality and hand recognition), their work provides precious insight about 3D creation in VR. For instance, participants showed a clear preference for staying in one place and rotating the virtual sculpture rather than moving around it physically. Moreover, the interactions they developed and tested, such as area selection and pointing, are present and enhanced in the software we used for our experimentations.

2.2 VR CAD

Computer-aided design (CAD) modelling differs from artistic software as it prioritizes precision and functionality for industrial applications, often at the cost of being immersive or intuitive to use. *Kukreja et al.* [1] addressed those problems by comparing several tools for designing CAD models in VR. Their work also provides an efficient methodology to evaluate systems with a training phase and a trial phase, which were performed by engineers with strong experience in modelling.

2.3 Features for modelling in VR

The evaluation of the feasibility for CAD in VR and identification of a user-friendly set of features for 3D modelling have been made by *Feeman et al.* [3]. Although their work focuses on modelling, they defined a set of actions and features that has to be implemented by VR modelling softwares to rival with current modelling softwares. Some of those features are present in both of the softwares we used for our experimentations, while some differ from one another.

Based on these existing studies, our contribution focuses specifically on comparing the efficiency of basic task completion between VR-based sculpting tools and traditional desktop setups, while gathering user feedback about the interactions with the different softwares.

3. Experiment

3.1 Experimental setup

We used two programs for the evaluation process. For desktop settings, we used Blender as the main program of use, while for the counterpart in VR, we opted to use a program named Shapelab.

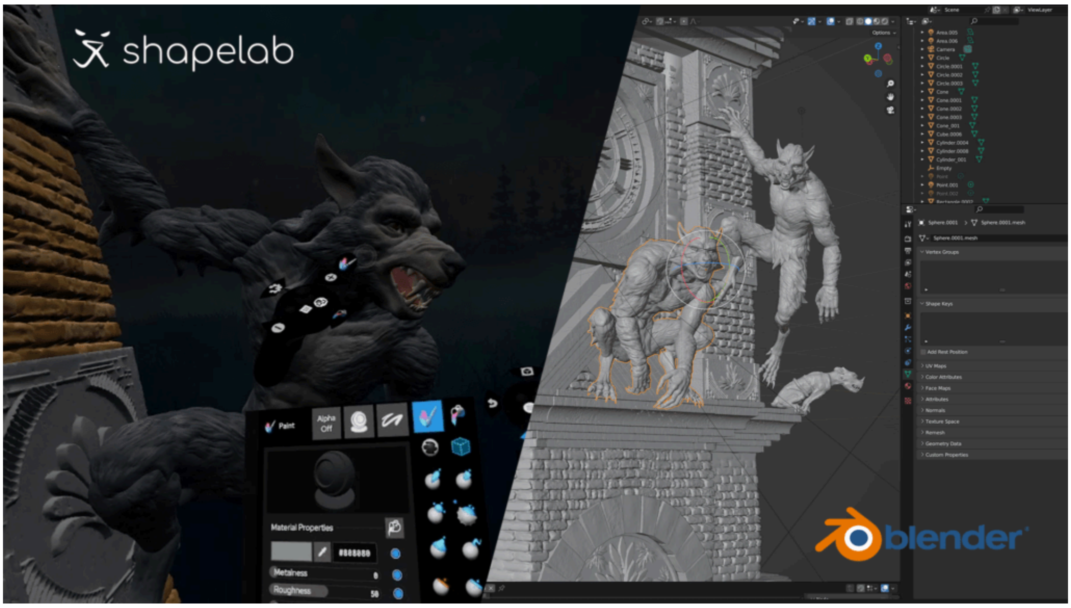


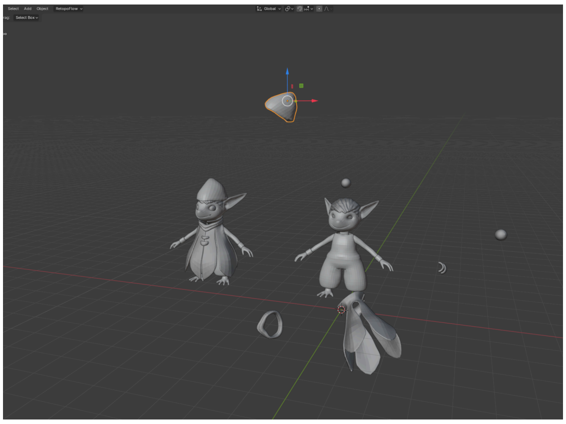
Figure 1. Shapelab and Blender

For the tests done in Blender, the testers are instructed to use a combination of mouse and keyboard, as well as a graphics drawing tablet for the task of sculpting. For the task in VR, the only tools required are the VR headset and controllers themselves. The graphic tablet in use is a Huion HS611, while the VR set used is a HTC Vive pro and its controllers.

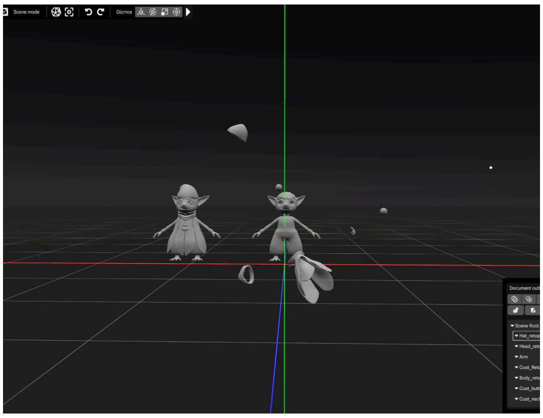
3.2 Structures of the experiments.

For each participant, we allocated 10 minutes of training time with each setup, totaling 20 minutes of preparation. During this part, we introduced the participants to the tools, gave them instructions on some of the basic navigations of the view camera, and manipulation of objects inside the programs using Gizmos. We provided some helper tools to cut down the time the participants have to learn the programs' interfaces, instead to work directly with performing basic transformation of the objects. In Blender, we provided an easy-to-access alternative method of using the Gizmos for the tester via a builtin add-on for a helper radial menu. With ShapeLab, unfortunately this was not possible, due to the lack of buttons on the HTC Vive pro controller that could have enabled some radial menus for quick tool access.

We set up two tests for each medium, each is also 10 minutes long. The first test aims to evaluate the accuracy and speed of participants in performing transformations to 3D objects in the viewport and VR space. The participants are given a reference character model, and a duplicate with some accessories scattered around. The goal is to bring the scattered items back to where they are supposed to be on the duplicated model.



a)



b)

Figure 2. a) Scattered models in Blender, b) Scattered models in ShapeLab

Participants are required to place the scattered items back to where they are supposed to be according to the reference model

For the second test, we asked the participants to sculpt a simple rock, given a reference model made by our team. We asked that the tester try to match the rock as best as they can. We provided the participants with some basic brush types for both Blender and ShapeLab, and gave them full freedom of approach on how to handle their sculptures.

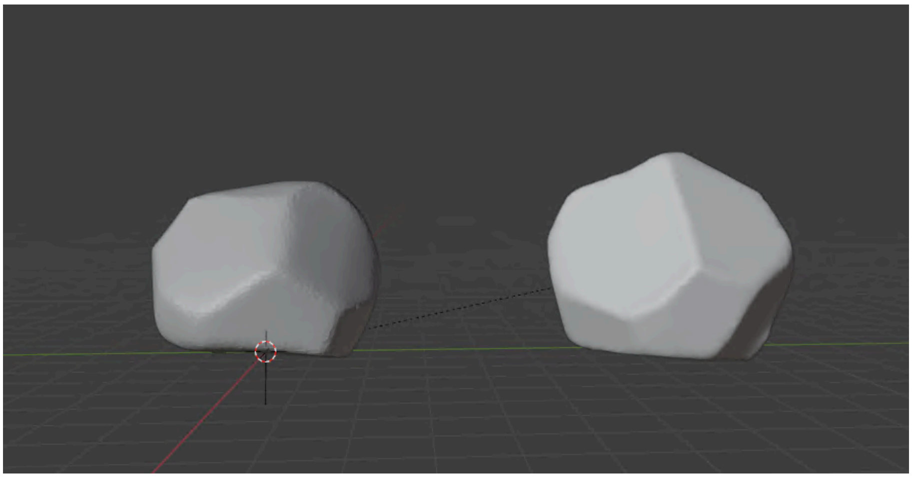


Figure 3. Reference model (Right) and a sculpted version of a participant (Left)

Finally, we ask participants to perform one final test, however, this time with a VR exclusive functionality. Generally, as explained above, transformation of objects in a 3D viewport are done via the help of Gizmos. Some programs such as Blender do support free transformations, but the 2D interaction severely limits it. With Shapelab, the participants have the ability to grab an object in space, rotate and translate the object and change view point simultaneously.

Between each 10-minute section, we asked the participants a few questions about their experience and allowed roughly 5-minute breaks to recover from the fatigue of the previous tasks. We recorded the experiments using a webcam, and used it to approximate the time the testers spend on navigating the viewport versus actually performing transformation tasks.

4. Results

Due to the nature of the experiment, which is approximately 3 hours long, we were only able to perform on three participants. One of which is a former 3D animation student, while the remaining two are relatively new beginners. We will refer to the participants as A, B and C accordingly.

4.1 Experimental result

Participant	Task	Medium	Total time taken	Tranform time	cene view change tir
A	Object Transform	Blender	8	6.45	1.55
		Shapelab	9	7.125	1.875
	Rock sculpting	Blender	10	9.375	0.625
		Shapelab	10	9.39	0.61
	Object Transform v2		5	3.765	1.235
B	Object Transform	Blender	10	8.1	1.9
		Shapelab	10	7.5	2.5
	Rock sculpting	Blender	5.6	4	1.6
		Shapelab	10	8.26	1.74
	Object Transform v2		6.8	5.85	0.95
C	Object Transform	Blender	8.5	6.8	1.7
		Shapelab	7	5.56	1.44
	Rock sculpting	Blender	10	7.7	2.3
		Shapelab	7.5	7.5	0

Table 1. Time spent on activities during the experiments by participants

The results proved to be inconclusive when it comes to comparing purely the time spent on manipulating the model and that spent on changing the view of the scene. According to the recorded footage, this discrepancy is mostly due to personal habits of the participants. It is important to note that the numbers here do not tell the whole story. A large portion of time was spent on changing viewpoints to compare to the reference models. Despite being able to change viewpoint by just turning one's head, it is interesting to note that participant A with prior experience seems to be set in their habits and did not make use of this very much. On the other hand the two beginners seemed to adapt much faster to this new method of working. One thing that was unanimous between the participants was that: with the ability to grab an object in space and free transform it simultaneously, the placing test improved in time spent significantly, by as much as half the time.

4.2 User feedback

We gathered user feedback along each experiment, by discussing with the user between each step of the said experiment. We asked about the feeling of control and precision of interactions with each software for each task, and we discussed the fatigue experienced.

Results of those discussions highlight clear distinctions between Blender and Shapelab in terms of usage and efficiency. Blender was preferred for its precision, and detailed tools and interface, even though users felt that it was difficult to master and mentally tiring due to its complex controls. In contrast, Shapelab was preferred for its intuitiveness, ease of use, and fluency (user A and B felt it "organic"), but it lacked the precision for movement and fine detailing. This lack of precision, especially in the movement when the users were moving objects, is mostly due to the shaking of their hands after a few minutes of holding the controllers. It could be solved by some stabilisation of the output movement, or the parametrization of controllers sensitivity, but those features were not implemented in Shapelab. The same way, precision in Blender is allowed because of certain features such as snapping or transformations by typing values, features that are not in Shapelab either.

Finally, the physical demands of VR setups, including wearing a headset and repetitive hand motions, made Shapelab more tiring overall, despite its engaging workflow. Users concluded that Shapelab is ideal for general or organic forms, while Blender remains the preferred choice for precision and professional workflows, especially where accuracy is critical.

5. Conclusion

In conclusion, while traditional desktop sculpting tools such as Blender are better for precision and detail tasks, VR sculpting offers significant advantages for the creation of large and organic shapes. Therefore, it can be seriously considered as a step of the 3D design process, for applications with organic designs such as character design. As of so far, the greatest strength VR offers is the power to perform many actions simultaneously, and this should be further enhanced and exploited to bring the experience to surpass the efficiency of traditional desktop setting. Note that our experience is heavily influenced by the specific features and limitations of the software used. This highlights the need for further development to establish conventions and consistency in features and interactions between VR and traditional 3D software. Finally, a more refined experimental protocol might be useful to collect more metrics, in order to evaluate and compare results with more accuracy.

References

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