Medieval Sword Forging
Treatment Document

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1. Motivation

Set back in 1352 in England, the medieval sword forging and training simulation allows the user to experience the art of forging a sword at the blacksmith's house. After the sword has been forged, the user will be able to swing it at a training dummy and test it. While this simulator is intended to show the steps necessary to forge a sword, it is by no means a real simulator, as forging a sword in real life requires many more steps and time. Therefore, this virtual reality (VR) experience is mainly for entertainment purposes but can serve as a building block for future simulators. We introduce in the mechanisms a sword-holding mechanism that can be used for other sword simulators.

2. Scene Design

2.1. The Blacksmith Area

As our initial idea is based on having two key areas, namely a blacksmith area as well as a practice area, a floor plan is needed for each. In the following figures are the two-floor plans for the above-mentioned areas.

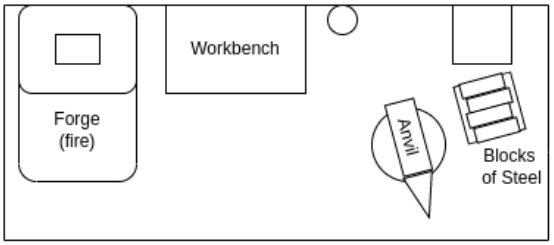

Fig 1. Diagram representing a floor plan of the blacksmith area.

The blacksmith area has a few key components when it comes to its design. The key features include a box which holds blocks of steel, a forge for heating up the steel, a workbench on which the tools needed to hold (tongs) and shape (hammer) the steel is located, and an anvil which is the typical hard object used to shape a block of steel on. Shapes with no label, are just background pieces that the user will not be able to interact with.

Fig 2. The 3D Modeling of the house[1]

2.2. The Training Area

What use would it be if the user spent all this time forging a sword and were not able to use it? This is where the practice room comes into play and the floorplan can be seen in Fig 2. The main aim of the practice room is for the user to be able to use their newly forged sword on objects such as a training dummy.

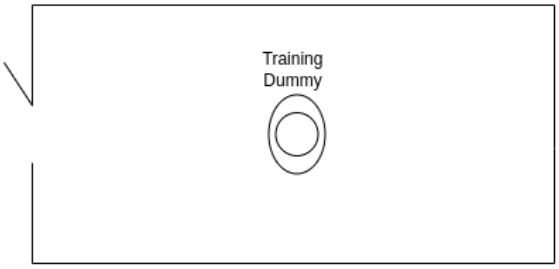

Fig 3. Diagram representing the floor plan of the practice room.

Fig 4. The training room can be seen through the door, with a table, which on top the training dummy will stand[2]

[1] Sketchfab, https://skfb.ly/6ZUrW
[2] Sketchfab, https://skfb.ly/6ZUrW

3. Interaction

The main interaction in this virtual environment will be to forge a sword, in a simplified process as can be seen in Fig. 5. The process is as follows:

1. Locate the block of steel (in the box), the tongs (on the workbench) and the hammer (also on the workbench).
2. Use the tongs to pick up the block of steel and take it towards the forge (fire). Place the block of steel into the forge for a minimum of n seconds, where the value of n depends on user testing (Section 7).
3. Once the block of steel has been heated up for n seconds, it starts glowing and is now a hot block of steel that is able to shape with a hammer. This hot block of steel should be taken and placed on top of the anvil. The user will then need to pick up the hammer with their free hand and hold the hot block of steel in place with the tongs on the anvil.
4. Hit the hot block of steel with the hammer until a shape starts to form, but at the same time the user needs to ensure the steel does not get cold again, otherwise, it will need to be reheated.
5. If the block of steel has been hit k times, k will be determined through user testing as well, and a shape of a blade will start to appear. Once the shape fully appears the sword's blade is complete.
6. The final step of the sword forging process will be to attach the handle to the blade. The handle (which will be on the workbench) needs to be attached to the blade in the correct orientation in order for the mechanic to work, otherwise, the user will have to keep on trying.

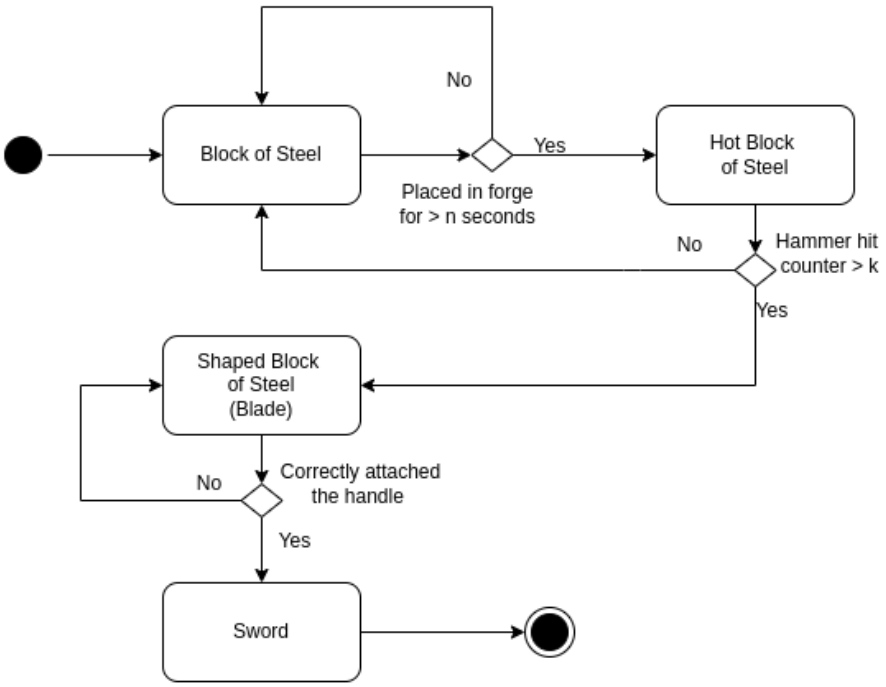

Fig 5. State diagram representing forging process

The secondary interaction in this environment will come in the form of a gamified practice room where the user will be able to practice their sword skills on a training dummy.

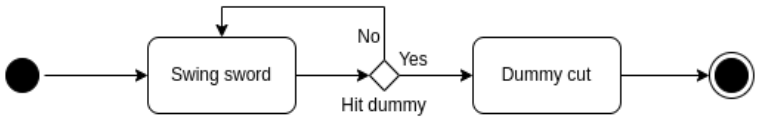

Fig 6. State diagram representing the practice room

4. VR Mechanisms

4.1. Menus

The experience will start with a fairly simple menu, letting the user choose between starting the experience or exiting the experience. There will be no intermediate saving of state or "levels". Although this can affect user experience (UX) for the worst, this has to be done due to constraints such as timeframe. The menu will be accessible through the secondary button on the left controller.

4.2. Help

This VR experience will have no Graphical User Interface (GUI) to keep the screen clean and not obstruct the user view. Before each step, we will add a narrative voice (Sebastian's voice) explaining to the user what is the next step to eliminate any confusion.

4.3. Environment and Clutter

The environment will have as little clutter as possible. There will be some unmoveable objects, but those will be used moderately to create a creditable medieval environment. For example, not all blocks of metal will be moveable. The workstation, pile of metal, anvil, forge and training dummy will be at the height of the avatar. This is to avoid placing items too low and causing issues with controller tracking.

4.4. Teleportation

We will use the Unity default teleportation method (transform.position) to allow the user to move between the different rooms and locations on the scene. The user will use the controller left/right arrows (left/right) to rotate the view and the up arrow to teleport to the location they are looking towards.

4.5. Picking up Objects

Objects that can be picked up will be marked with a halo around them. To pick up objects, the user will have to stand next to them, touch them (with a threshold) and press the right or left trigger. Depending on which trigger the user has pressed, the relevant hand will pick up the object and hold it until the trigger is released. As long as the trigger is pressed, the object is being held. We chose this method over holding and releasing upon trigger clicks, to simulate the pressure of actually holding the item, by mimicking holding the trigger.

4.6. Tongs

The tongs will not act as normal object as it has two modes: opening/closing and holding. The tongs can be picked up using normal picking with the trigger. Once picked, the user will be able to open/close the tongs using the secondary button on the right controller. If there is a piece of metal within range (with a threshold), it will glow with a halo, at which point the user will have to click the secondary button again to attach (or catch) it and close the tongs. Opening the tongs again using the secondary button will release the piece of metal onto the ground.

4.7. Sword Alignment

Once picked up, the sword acts differently than other objects. To swing it, the user will have to place the two controllers in alignment on top of each other, mimicking them as if they were holding a real sword. This will require some controller tracking in Unity and a bit of novelty regarding the UX with the VR controllers. Swinging will work only if the aligned controllers are swung at the same time in the same direction, keeping the alignment. We must address a few challenges with our user testing, such as “Gorilla arm” - The fatigue of the user holding their arms in an unnatural way.

4.8. Swinging Hammer

The hammer will be picked up using one controller as a normal object. Swinging of the hammer on the metal will be used using controller movement detection and swinging of the controller itself. This will be one of the most complicated actions for the user, as the user will need to use one hand to swing, and another hand to hold the metal with the tongs. User testing will show us how to modify this and simplify this process, for example fixing the metal and the tongs without the need to hold them.

4.9. Attaching the handle

Attaching the handle will require the user to hold down the blade on the anvil with one hand while pushing the handle with the other. As in the previous subsection, this UX might prove difficult and we will have to simplify it by fixing the blade on some sort of holder, so the user can freely attach the handle without worrying about the blade moving.

4.10. Sound and Haptic Feedback

Every swing of the sword or hammer, hit of the hammer on the hot metal and the fire crackle will be simulated using realistic audio (see Section 6). In addition, the hitting of the hammer on the metal and the sword on the training dummy will cause vibrations (haptic feedback) in the controllers.

5. Object Design

5.1. Item Slicing

As the majority of the objects we will use for this environment were found online on websites such as Sketchfab, this eliminated the need for us to design any of the objects ourselves. The only true object design scenario that needed to be considered is the slicing of objects such as the sword into its different components and the

pre-slicing of the objects that will be used in the practice room such as the practice dummy. All files are in GLTF, GLB or FBX format.

As mentioned, we could not find a sword object that is separated into its components, so we will have to use Blender to cut the sword into the blade and the handle parts. We have all the original blender files of all the objects. Finally, the fire effect and the metal block will be made natively in Unity using online textures, Unity shapes and FX effects.

5.2. The Sword

The sword was carefully chosen, as we searched for a big sword that represents the 14th century swords. The chosen sword is a replica of a real sword named "Moonbrand". What was interesting for us when looking for swords was that the handle and the blade are properly separated, which will allow us easier and smoother cut operations in Blender.

Fig 7. Sword object[3]

5.3. The Hammer

The hammer is a fairly simple object that just needs to be picked up and used against the hot metal. Therefore, we chose a free, simple object.

Fig 8. Hammer object[4]

5.4. The Training Dummy

The training dummy, as the sword, was chosen to represent a real training dummy from the 14th century. In addition, we wanted to have a simple dummy that can be cut in Blender to mimic the cutting with the sword.

[3] Sketchfab, https://skfb.ly/6XXLo
[4] Sketchfab, https://skfb.ly/6RXoE

Fig 9. Training Dummy object[5]

5.5. The Tongs

The tongs are simple and are seperatable in Blender so we, so we can allow animation of opening and closing.

Fig 10. Tongs object[6]

5.6. The Avatar

The avatar is not as important as the other elements, as we will not have mirrors or other players in the environment. The hands and lower body of the avatar will be visible if the user looks around, and the avatar will be attached to the main camera. The avatar was created using ReadyPlayerMe, and is inspired by fashion of the time.

[5] Sketchfab, https://skfb.ly/6RTEQ
[6] Sketchfab, https://skfb.ly/o8sDB

Fig 11. Avatar object[7]

6. Audio Assets

The following audio assets will be used to aid in the users sense of immersion. Each sound effect was chosen with a specific purpose in mind, each of which is explained below.

6.1. Hammer on steel[8]

Helps the user know when they are making contact with the block of steel, a sense of immediate feedback.

6.2. Fire crackle[9]

Simualtes the fire burning in the background which will give the virtual environment a sense of ambience.

6.3. Sword swing[10]

Indicate that the alignment of controllers is working and the user has successfully swung the sword.

7. User testing

User testing is an important step in the development of this environment. There will be only two iterative test processes, as the timeframe does not permit us to do more. The first testing process will start after the initial functionality is developed and ready. Two users will be chosen (friends and family) to test it without any guidance from us. After their test, the feedback will be collected and written down. Then, we will re-develop and fix any feedback that can be addressed in a timely manner, and re-iterate this process once more. After this iteration (two in total), the testing will be concluded. Feedback that cannot be fixed within the timeframe will be documented for future development.

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[7] ReadyPlayerMe, https://readyplayer.me

[8] https://www.fesliyanstudios.com/royalty-free-sound-effects-download/hammer-hitting-metal-57

[9] https://www.soundjay.com/fire-sound-effects.html

[10] https://opengameart.org/content/swishes-sound-pack