THE BEAUTY OF

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~The Beauty of Beat Saber~

'What we can learn from the most popular VR game to date'
by Aidan Harrison

Virtual reality (VR) technology is rapidly gaining mainstream acceptance and is expected to become the primary computing platform for a significant portion of the population in the coming decade/s. As VR technology continues to evolve, it is becoming increasingly dependent on software and infrastructure to drive its growth and adoption.

With the majority of hardware-related issues being addressed, the focus is shifting towards the development of high-quality software to drive the sales of VR devices.

One such example of a successful VR software that has driven many of the sales of VR hardware is Beat Saber, a popular rhythm game that was released in the early days of the medium.

There are plenty of S tier VR games out there, to name a few:
- H3VR (Hotdogs, Horseshoes & Hand-grenades)
- Half-Life: Alyx
- Blade and Sorcery
- Compound
- Space Pirate Trainer
- Most racing games (Asseto Corsa, Gran Turismo 7, etc.)
- No Man's Sky
- Bonelab
- Pistol Whip
- Stride

So what makes Beat Saber stand out so much? Why is it #1 in most charts and how has it stayed at that position since release?

More importantly what can we learn from it and how can it be applied to VR game development.

Beat Saber has the following core characteristics:
- Stationary
- Zero resistance
- Ghost body
- Rhythm
- Mental & physical engagement

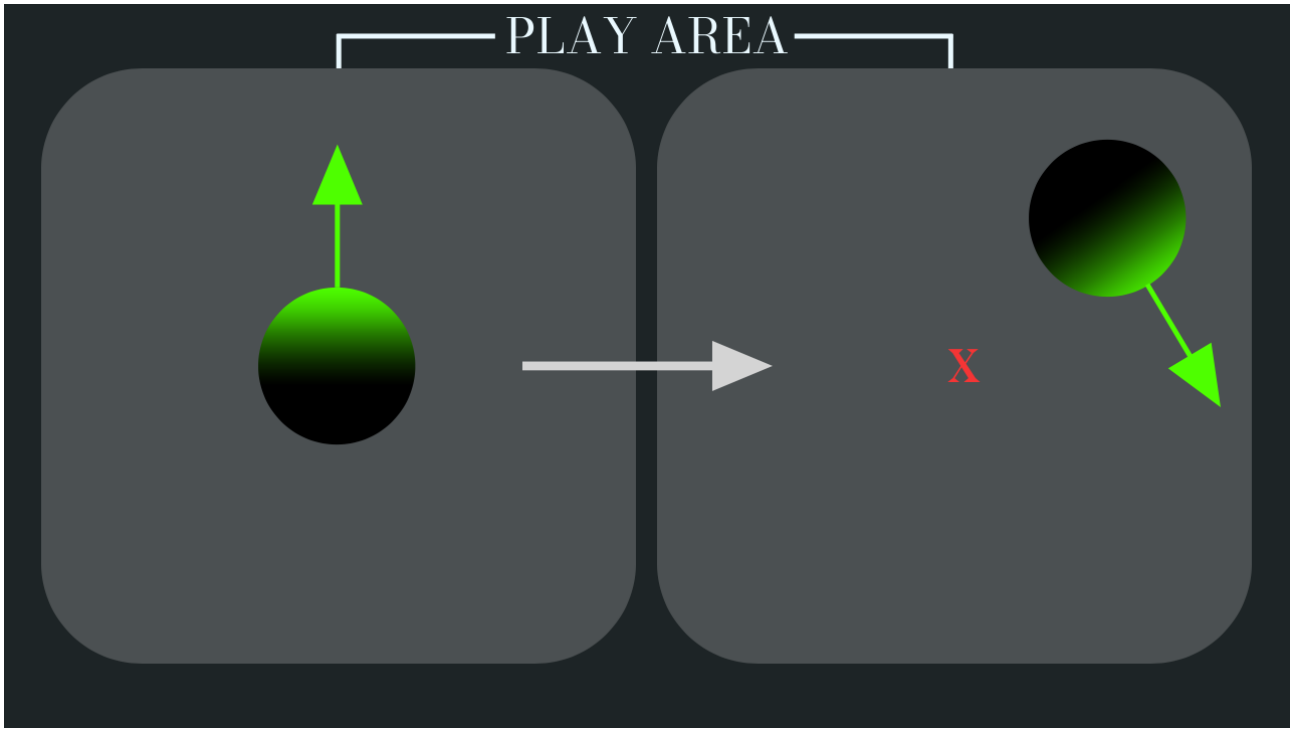
1) Laterally stationary
The brain primarily values the following:
- Visuals
- Audio

Stationary experiences if done right prove to have zero impact on immersion as standing still is something which happens in the physical reality (which from now on we will refer to as PR). Problems regarding movement occur when said movement begins to hinder:
- Space constraints
    - Most people don't have too much room to use a VR device, encouraging or enforcing movement will alienate a great deal of players
- Core gameplay elements
    - Moving in PR should rarely be a primary form of input due to the previously mentioned space and several other aspects we will touch on later
- Basic interactions
    - Things which should be simple can be made annoying when incorporating PR movement. A perfect example of getting around this is Half Life: Alyx's gravity grab. **Easier to move something towards you then you to it**

There is a larger aspect to movement in VR however which is where the major problems start. Collision. In PR your body is occluded by physical objects, in VR, those ‘virtual’ physical objects don’t exist. If you were to walk in real life towards a house in VR you could just walk through the virtual house which would be game breaking.

Adding collision to the virtual body would only partially solve this as a disconnect would occur between the virtual and physical body, while the game breaking aspect has been fixed, the immersion is arguably worse as the human brain is not fond of self disconnects (More on this later).

Spatial disorientation is a given when in VR as the PR is completely removed from the players vision, the brains ability to track space is severely hindered. This leads to a common problem of players removing the headset and ending up in a different location and orientation to where they started, leading to a jarring transition between realities and a consistent need to recenter.

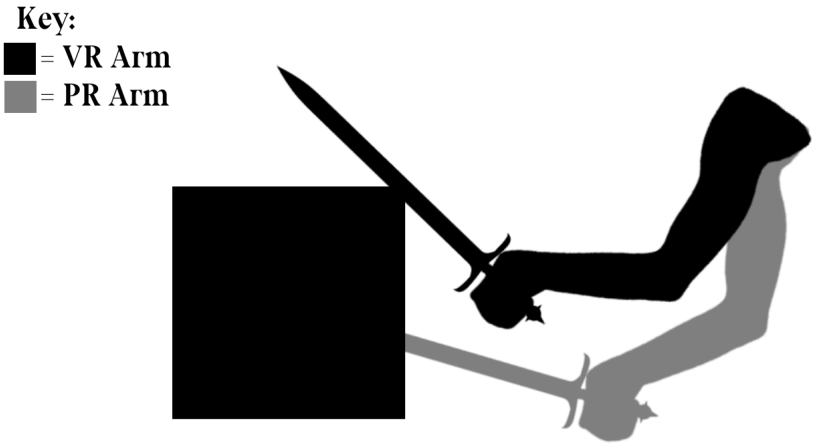


Beat Saber does not encounter this issue as lateral movement serves no purposes as well as the rotation remaining the same through the entire play session. This makes Beat Saber one of if not the most comfortable VR game to play as is one of the core driving forces behind its success.

2) Zero resistance

Blade & Sorcery is known for having physics based combat, simulating the weight of objects as well as the object -> object behaviour in a realistic way. This produces a satisfying core gameplay experience and works well in the majority of cases, however, it can quickly encounter issues and has edge cases of failure which break immersion.

The most obvious problem was previously discussed. Collision. Once again collision in VR is a point of contention. Let’s take the following example:



Here the sword impacts the object as expected, stopping appropriately and reacting with the IK (Inverse kinematics) of the VR players skeleton. In PR however our hand is not abruptly stopped nor does it follow the impact afterwards, quickly causing the brain to disconnect, temporarily lowering immersion. **If this object has physics this disconnect is lessened considerably due to an expected reaction occurring but it cannot be avoided entirely.**

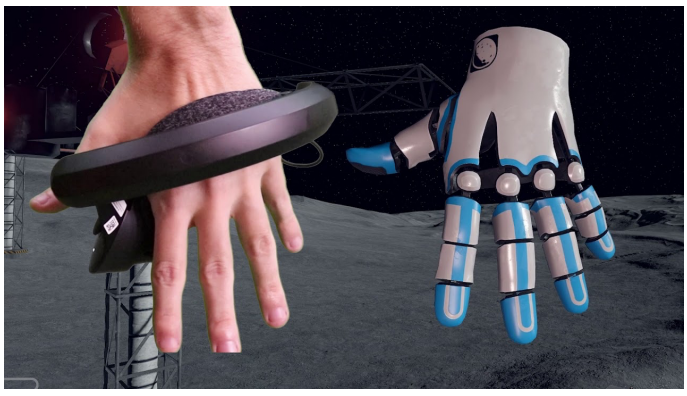
In Beat Saber's case hitting blocks provides zero resistance, (as you would expect from a lightsaber) instead the block is satisfyingly sliced in half based on the direction of the swing, accompanied by some SFX and VFX.

This zero resistance high response design makes hitting a block a pleasure resulting in a fundamentally enjoyable experience. Hitting blocks can never become a hinderance, only the skill of the player can, providing a healthy loop of the player bettering their abilities through themselves alone without the game being the problem.

3) Ghost body
B&S gives the player a full body to handle collisions, assist in immersion and for gameplay mechanics such as the armour system. Two other notable full body games are Boneworks and Bonelab however these implement a fully physics driven body as opposed to B&S's semi physics driven.

As previously stated, minor disconnects between the PR and VR body break immersion, making collisions an easy axis to hinder player experience if not finely tuned. Tuning collisions could be done by making the weight of objects less or more than what they should be, or, by making hitboxes smaller than the model to slightly account for the PR arms going through everything.

'Hands' are another point of contention which need to be implemented in some way to represent the controller. In some cases the controller being used is a perfectly fine representation as it

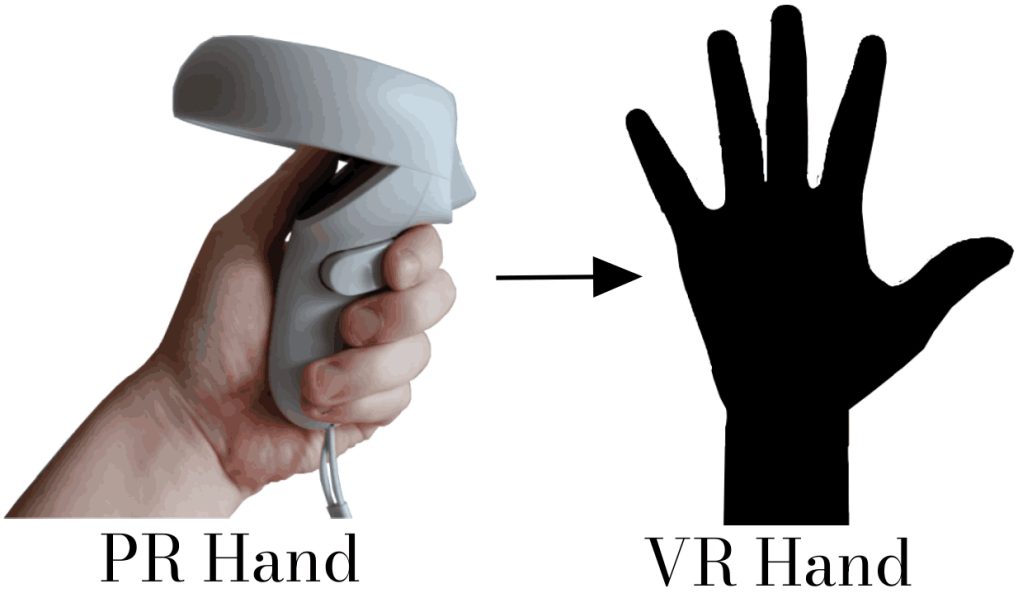


Finger tracking controllers such as Valve's Knuckles don't encounter this issue (Assuming virtual 'hand' is a hand)

matches what is in the PR, minus the players hands and assuming perfect tracking, a controller provides a 1:1 experience.

In many cases however a representation of the controller won't cut it as the game will most likely require some form of hand or another type of object to fit its design:
Beat Saber solves this issue by replacing the controllers with well, sabres. This specific implementation works well for the following reasons:

- Grip from PR to VR remains the same, holding a controller is the same as holding a sabre
- Being weightless provides zero disconnection between movement
- No physics related collisions



Poses of PR does not match VR hand

4) Rhythm
Rhythm games are naturally high in their ability to achieve "flow state" by requiring the player to abide by a pattern in order to succeed. Pattern adoption yields itself to engagement naturally being the core driving force behind rhythm games. VR's natural immersion combined with rhythms natural immersion yields an inherently high engagement, intense, fun experience.

5) Mental and physical engagement
Most games for most people are mentally engaging, but few games are physically engaging. The first games and console which comes to mind is Wii with its hit best sellers; Wii Sports, Wii Fit and Wii Sports Resort. Nintendo have also dived into physical gaming recently with Ring Fit Adventure on the Nintendo Switch, although that proves to be a more gruelling exercise regime than a game.

VR is an excellent foundation for physical and mental engagement gaming, with even the lightest of VR games still requiring movement, standing up for long periods of time, or short bursts of high activity. Beat Saber hits both nails on the head due to the following:

- The player is forced to move in order to hit notes
- The player is forced to play the duration of the song in order to get a valid score
- The rate of notes and movement complexity technically has no limit, extreme map with 1000's of notes are challenging for both the brain and body
- Rhythm assists in entering flow state thus increasing mental engagement, reducing the physical exertions effect on the player (Exercise which is fun doesn't feel like exercise)

Applying Beat Saber to VR development

1) Minimal PR movement

Moving around in the physical world can increase immersion when done in short small bursts, such as stepping forward to reach something far away, however, utilising PR movement consistently and for core gameplay elements causes the following issues:

- Larger space requirement
- Disorientation
- Collision disconnect
- Flow

2) Resistance

Physics based games such as B&S and Bonelab strive on being physics based and provide resistance to simulate the feeling of weight. Beat Saber on the other hand avoids resistance entirely to provide the smoothest experience, therefore there are two paths to go down:

- Resistive/Realistic/Physics
  Simulate weight through delayed actions, heavy objects and resistive collisions
- Non-resistive/Arcade/Void
  Have zero weight, little to no collisions (Outside of necessary) and static worlds OR non physics driven dynamic worlds

3) Mental and physical engagement

Exercise which is fun doesn't feel like exercise

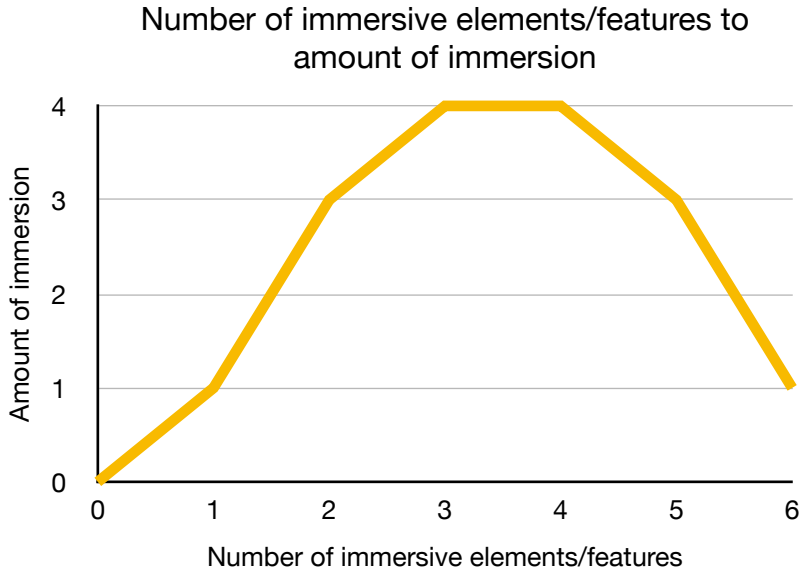
Take full advantage of the medium and encourage non lateral movement, relying on vertical movement (Primarily ducking, crouching and even proning) to raise the physical engagement factor. Tie physical and mental engagement tightly together, for example, placing pickup locations in areas where physical engagement is required; ladders, crouching, swinging/hanging, etc.

Avoid using controller buttons for interactions for a majority of input, for example, reloading a gun.

4) Core mechanic

VR is still in its early days, design paradigms are only just being figured out, therefore sticking to a core mechanic which takes full advantage of the medium and building an entire game around it is more beneficial than trying to create a game with many smaller mechanics interlaced together. For example RPG's or large scale open worlds have yet to be properly achieved in VR.

Amount of immersive elements/features:



Arbitrary values, undefined features, general representation

In conclusion, Beat Sabers success is driven by perfectly abiding to the constraints and freedoms of VR while providing a satisfying core gameplay loop, combined with its modding capabilities through custom beat maps as well as multiplayer and customisation options. Beat Saber is a virtual world which can consistently provide engagement on every level for long periods of time.

Playing Beat Saber is genuine exercise and CAN be used to lose weight, gain muscle, improve mobility and generally improve overall health if played consistently. Expert maps are intense both mentally and physically and modding provides a challenge even to the most skilled of players. This means nobody could stop playing Beat Saber because there isn't a challenge as a beat map can always be made harder.

A game which pushes both the mental and physical to their limits is rare yet exquisite

Beat Sabers core elements are:

- Stationary based with minor movement for crouching or sidestepping
- High physical engagement
- Rhythm based
- Simple and focused
- Ghost body
- Void of physics
- Zero resistance