# Design

The product will be a video game playable on a windows PC. The gameplay will be based on the commercial dexterity game *Junk Art* [21], a game revolving around stacking objects with unusual shapes, with the goal of creating the tallest structure, or incorporating the most pieces, without the structure collapsing.

The core gameplay loop will involve each player in turn being randomly assigned an game piece to be added to their structure. The player will have the ability to move and rotate the active piece, before placing onto their structure, ideally without any pieces falling off. As each player’s structure grows, adding more pieces will become more challenging, until a collapse occurs. This asynchronous, turn-based approach will allow multiple users to play on the same machine, allowing a multiplayer experience without the need to incorporate online play (which would greatly increase the required development and testing resources).

The game will manifest as a representation of a tabletop holding the game pieces. The player will not have an avatar within this space, but rather will use keyboard and mouse to manoeuvre the camera around the environment, similar to the sandbox environment implemented in *Tabletop Simulator*. These camera controls will by default use WASD keys for translation and mouse XY for rotation. This interface will be familiar to anyone with experience of modern video games, and should be quick to pick up for those without that experience.

When the player selects a game piece to add to their structure, they must be able to manoeuvre it with six degrees of freedom – three dimensions of translation and three axes of rotation. The system employed by *Garry’s Mod* will be a basis for this, with additional control to add the final rotational axis missing from that implementation. Translation will follow camera movement: as the player moves and rotates the camera, the held piece will stay at a fixed distance from the camera, held at its centre. The mouse scroll wheel will be used to adjust the distance between piece and camera. By holding an additional command key (e.g. ‘Space’), the player can switch to rotation mode; the mouse XY movement and scroll wheel will adjust the piece’s rotation within world space, with translation of piece and movement of camera disabled while in this mode.

Aside from the 3D world containing the game pieces, the game window will contain several interface elements which are not part of the physics environment. An initial plan for the layout of an in-progress game is illustrated in Figure 6. Elements will include ‘scorecards’ with information on the game status of the active player, and each other player, taking inspiration from other stand-alone digital board game adaptations such as *Catan Universe* and *Carcassonne Digital* [22]. This will include points scored in the current game (height of structure) and any penalties accrued from pieces falling from their structure. In a physical game, each player would be randomly assigned a differently shaped component to add to their structure by drawing from a shuffled deck of cards, showing representations of each possible piece. This may be replicated by an interface element, rather than by creating card objects within the 3D environment, which would be needlessly fiddly. Alternatively, a randomised piece may be spawned directly into the player’s ‘hand’.

*A diagram of a computer

Description automatically generated*

*Figure 6: Game layout*

A button will allow the player to indicate their turn has ended and pass control to the next player. It is possible that this element may not be required, if the game can be configured to detect when the active player has completed all required actions on their turn and automatically advance to the next player; this would not form part of a minimum viable product, but it is likely to create a smoother playing experience and so would be a desirable feature.

The game will need to detect when one or more game pieces fall from any player’s structure. Collision detection and object velocity calculations will trigger functions to indicate whether a player has been eliminated due to a collapsed structure. This will also be linked to audio routines to trigger sounds of components falling and striking the tabletop.

The software will be primarily build using the Unity game engine. This development platform allows for creating and configuring the 3D game environment, physics simulation, and 2D interface overlays. It also allows building of the software for multiple platforms, potentially increasing the range of users for both testing and as users of the final product.

Unity includes by default only primitive 3D components. This will be useful for the prototype phase, but to create the unusual shapes which are key for this game, separate 3D modelling software is required. These custom components will be created in Blender. It will be important to create both the render models and also reasonably high-fidelity mesh colliders. Low-vertex box colliders are often used in 3D games to reduce CPU load, however this game revolves around how specific unusual shapes interact, and generic box colliders would remove these different interactions.

The game pieces will be modelled after the components used in the physical game Junk Art, as shown in Figure 7, with a detailed plan of each piece type shown in Figure 8.

A toy on the floor

Description automatically generated  
*Figure 7: Physical game pieces*

A graph paper with various objects

Description automatically generated with medium confidence  
*Figure 8: Game pieces to be included*

2D interface elements will utilise premade assets acquired from the Unity asset store. This resource includes many collections of game UI assets, including free and paid bundles. A free bundle such as MiMU Studio 2D Casual UI [23] will be used for initial prototyping. Depending on the outcome of user testing and feedback, an alternative paid asset set may be required. Possible designs for the scorecard elements are shown in Figure 9.

A grid with a grid pattern

Description automatically generated with medium confidence  
*Figure 9: Scorecard designs*

# References

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