

THE T.R.U.S.T. GAME

Teamwork and Rapport Under Stress Training

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Fig. 1. Within *THE T.R.U.S.T. GAME*, two players are cooperating to complete a small jigsaw puzzle. Each player is only able to move half of the puzzle pieces, and their half of the pieces is invisible to them but not their partner, encouraging communication and cooperation in order to determine where pieces fit.

A majority of mixed reality games and other applications are designed to be either singleplayer or larger social experiences, with little in between. The realm of "couch" multiplayer games, where a small number of people gather in a living room and enjoy a more intimate social dynamic is relatively unexplored in virtual reality. Although players are isolated within their own headsets in the real world, VR multiplayer games allow players to enjoy the limitless virtual environment together and interact with each other in ways more novel and immersive than before. Inspired by co-op games such as *Overcooked!*[1] and *Keep Talking and Nobody Explodes*[2] which bring out both the high-fives and the friendly ribbing, *THE T.R.U.S.T. GAME* is an attempt to bring that intimate co-op experience to virtual reality with communication-based puzzles and minigames.

1 INTRODUCTION

Many of the most popular games and software applications today are geared to be social, from pure social media websites to smaller-scale multiplayer video games. In contrast, many VR applications are designed to be enjoyed alone. This is perhaps due to the VR's relatively small consumer base, which could be on account of a number of reasons, including price point and user-experience-related issues such as motion sickness, not to mention that the technology is recent and has not have had time to grow. If the market is to expand, utilizing the wide appeal of social applications appears to

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be a worthwhile endeavor; for example, one of the selling points of the recently revealed Apple Vision Pro is "connection," where the device offers convenient, life-size video calls, as well as synchronous document collaboration, all simultaneously available on a single augmented reality interface.

Although not on the scale of social applications such as Apple's FaceTime, *THE T.R.U.S.T. GAME* hopes to capture the intimate social experience of so-called "couch" co-op games available on console and personal computer. Such games were a large part of my developmental childhood, whether I was huddled around a TV playing *Halo Reach* on my friend's Xbox 360 or laughing about *Mario Kart* at yearly family gatherings with all my cousins. As new generations of kids grow up with VR, I hope they'll be able to enjoy such formative social experiences as I did.

Many multiplayer applications currently on the VR market seem to lack the more intimate social interactions that the aforementioned games seem to evoke in their players. The immersiveness of virtual reality doesn't seem to be at a level where people can feel like they're in the same room. To work past this and create a more involved and interactive experience, perhaps we can look to communication-based games such as *Keep Talking and Nobody Explodes*[2]. In this two-player game, one player is given a bomb defusal manual, and the other, the bomb; neither can see what the other sees, and so must solely rely on verbal communication to convey a multitude of

defusal instructions before the bomb explodes. This game mechanic based on separated perspectives was the prime inspiration for *THE T.R.U.S.T. GAME*, since VR headsets provide an easy way to provide players with things only they can see, which creates a reliance and emphasis on communication to work together and complete in-game tasks.

Taking an existing game, the jigsaw puzzle, and adding a twist, *THE T.R.U.S.T. GAME* distributes half of the puzzle pieces to each player and makes them invisible to their owner, but not the other player. Thus, each player must communicate and share feedback on the placement of each other's pieces. A time limit was added to increase tension between players and heighten the cooperative experience, making shared victories and losses more exciting.

This game concept appeared to be somewhat confusing, but at the same time, not engaging enough to playtesters. With enough time, I'm sure more interesting multiplayer games will arrive in the future and gain wide-spread interest, enough to encourage players to purchase and join each other in VR, such as battle royale games did for console and PC gaming.

1.1 Contributions

- Using the Unity game engine as well as its ProBuilder package, I created a 3D scene for the game, which features the jigsaw puzzle, puzzle board, starting room, and lighting.
- I took advantage of the Photon Unity Networking 2 (PUN 2) package to create a multiplayer experience, ensuring the jigsaw pieces and player movements were synchronized across two headsets.
- Writing scripts in C# and using Unity's built-in physics engine, I implemented jigsaw puzzle gameplay mechanics, where pieces are subject to gravity but will stick to the puzzle board, and the puzzle verifies if the pieces are in the correct position.
- I setup Oculus Quest 2 integration and created some UI with Mixed Reality Toolkit 3 (MRTK 3).

2 RELATED WORK

2.1 *Keep Talking and Nobody Explodes*

A cooperative game available on PC and VR where one player must communicate bomb defusal instructions to the other player. A clear example of the kind of communication-based gameplay that *THE T.R.U.S.T. GAME* is seeking to offer, especially with its premise of separated perspectives creating a reliance on communication to share information and collaborate. Since the instructions-giver must ensure the defusal steps are conveyed concisely and understood clearly, the game rewards familiarity between the two players, or "being on the same wavelength." For example, some of the symbols used in the game are Greek letters. If the instructions-giver knows the defuser isn't familiar with the Greek alphabet, they might not waste time trying and attempt to describe the symbol another way. In addition to such cooperative gameplay and use of separated perspectives, *THE T.R.U.S.T. GAME* was intended to add an element of deception to the mix, where players must cooperate, but also compete. Without time limitations, a scoring system and further deception-based mechanics would have been implemented.

2.2 *Overcooked*

Another cooperative game where 2-4 players must efficiently complete tasks in a single kitchen to serve as many orders as possible. Offering the ability to play with more players compared to *Keep Talking and Nobody Explodes*[2] and *THE T.R.U.S.T. GAME* creates a different group dynamic, where gameplay is more hectic but the communication required of the players is less involved or intimate. Again, no element of competition, unlike the vision for *THE T.R.U.S.T. GAME*.

3 METHOD AND IMPLEMENTATION

With Unity 2021.3.21f and baseline MRTK 3 packages installed and a fresh 3D scene, the requisite MRTK 3 prefabs, the MRTK XR Rig and MRTKInputSimulator, were placed into the scene. First, to create our Network Player prefab, we start with an empty parent object and give it a head, left hand, and right hand object, each with a sphere as its model. To allow PUN 2 to instantiate and keep the object synchronized across the network, give the parent object a Photon View component and the child head and hands objects a Photon Transform View component. To actually have the body parts follow the player's real-life movements, the parent object was given a Network Player script that reads the head and hands positions from MRTK and updates the position of the head, left hand, and right hand objects accordingly - but only if the Network Player object is owned by the current client.

To handle the networking, an empty object was given a Network-Manager script that connects to the PUN server and uses PUN's callbacks to set room options and create or join the room after connecting. This object was also given a NetworkPlayerSpawner script that instantiates the aforementioned Network Player prefab on the Photon network upon joining the room.

Unity's ProBuilder package offers tools to model a basic room in our 3D scene starting from a cube by making edge loops, creating extrusions, and more. With an enclosed room created, After placing some lighting objects around the scene, a puzzle board was modeled using ProBuilder as well, while the models for the jigsaw pieces were found online as a free asset. The jigsaw was not premade, and only provided a collection of separated pieces, so the pieces were manually assembled into a small 3 by 5 puzzle. Using an online color gradient generator to generate hex values, fifteen color materials were made in Unity and assigned to the jigsaw puzzles. The pieces also need physics and to be able to be picked up by the player. And so, a rigidbody and MRTK's Object Manipulator component were added to the pieces. Note that the puzzle pieces already had mesh colliders.

The puzzle pieces must snap to the board with the correct orientation once placed on the grid. To this end, square trigger colliders were created for each square on the puzzle board by placing the completed puzzle composed of the aforementioned pieces in front of the board, duplicating them and setting those aside to represent our actual pieces, then disabling the mesh renderer and rigidbody for the pieces left in front of the puzzle board and setting the mesh colliders to be triggers. Let's call these triggers our puzzle piece solutions, and the set aside pieces with rigidbodies will be called our puzzle pieces. Each puzzle piece was given a PuzzlePiece script



Fig. 2. Mr. and Mrs. Dinh playing *THE T.R.U.S.T. GAME* in my apartment.

which detects whether the piece comes into contact with a puzzle solution trigger. If it does, it "snaps" to the solution's position by matching its orientation and position and constraining the rigid-body's position and rotation to be fixed. The script also features an RPC function that releases those constraints. Notably, the script contains a reference to its corresponding puzzle solution object, so it can check if it's in the correct spot upon being placed in the grid.

To implement the puzzle's game mechanics, an empty game object was created and given a PuzzleManager script. This script features an RPC function to set the players' positions, a function to check if the players are ready to start the game, but, most importantly, functions to setup the puzzle pieces before playing, check if the puzzle is solved, and end the game. The PuzzlePiece script calls the function that checks if the puzzle is solved every time a puzzle piece is snapped to the grid. Setup involves attaching a transparent material to the puzzle pieces "owned" by the current player, as designated by assigning half the objects to each of the "Player 1" and "Player 2" layers, as well as starting the UI timer by calling a StartTimer() function on an attached Timer script and setting the player's positions using an RPC function in NetworkPlayer.

To achieve the outline effect upon hovering over the player's own puzzle pieces with the far ray interactor, the interactor's raycast was masked to only detect objects with its own layer (Player 1 or Player 2), and upon hovering, a callback on the piece's Object Manipulator component enables the Outline script on the object. This Outline script was taken from the QuickOutline Unity package.

Lastly, game over and game start Dialog objects were created as prefab variants of MRTK's Dialog prefab. The game start Dialog objects are instantiated on the Photon network by a DialogManager object and a script of the same name. Those Dialogs, once dismissed, tell the TagGameManager object that the players are ready and to start setting up the puzzle. Once the timer runs out or the puzzle is solved, the game over Dialogs are instantiated and reset the game once dismissed.

4 EVALUATION OF RESULTS, BENEFITS, LIMITATIONS

During the demo session, the invisible pieces concept appeared to be a little confusing to new players. Being only able to move the invisible (or rather, mostly transparent) pieces and not the visible ones was unintuitive. The pieces were made only mostly transparent and not fully invisible in order to reduce the frustration of trying to locate the pieces around the room. However, being able to see these pieces reduced reliance on communication with your partner, which defeats the intention of the game, a trade-off that does not seem worthwhile. Furthermore, once the players understood the concept, some grew bored, perhaps due to the lack of required communication - at this point, the gameplay is just placing pieces on board until the silhouettes look wrong. Many also lost to the timer, making a lose-lose situation. Perhaps a different gameplay concept aside from a simplistic jigsaw puzzle would have garnered more interest. Since the invisible object gameplay mechanic was unintuitive, perhaps leaving that behind and instead placing players in completely separate environments, such as in *Keep Talking and Nobody Explodes*[2] would have been conceptually easier to understand.

5 FUTURE WORK

For the growth of mixed reality and its social applications, targeting essential everyday functions such as video meetings would be a great way to appeal to a broader audience. Apple with their Vision Pro HMD seem to have similar intentions. Something akin to the Metaverse seems to be inevitable with improved execution and technology.

As for multiplayer VR games in particular, competitive games appear to garner the largest communities, and so, creating a competitive multiplayer game with broad appeal that truly leverages the controls and interactions made possible by VR (such as *Beat Saber* does with its motion controls) seems like a promising approach. Multiplayer games create buzz and lead consumers to rope in friends and family to join the community as well. Making a game viable for competition leads to the formation of a core group of players dedicated to the game, leading to longevity and continued growth in a game's lifespan. The *Super Smash Bros.* franchise is a great example of this; with appeal to both casual and competitive gamers, its playerbase has remained massive over the years, the competitive scene across multiple games still thriving.

In comparison, little "couch" multiplayer games made for VR will have their place, with improved design and execution as well as a larger VR consumer base as developed by aforementioned influential multi-user games and applications.

6 CONCLUSION

Although *THE T.R.U.S.T. GAME* has shortcomings in game mechanic design, it hopes to be a proof of concept for "couch" games intended to evoke intimate, more involved social interactions amongst a small group of friends or family. As this genre grows further, developers can build off each other's existing ideas and create better and better games that truly make the most of VR.

ACKNOWLEDGMENTS

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REFERENCES

- [1] Overcooked: Cooking video game: Team17.
- [2] Keep talking and nobody explodes.