FoxXO Game Design Document

Rev. A

James Richey

Apr 19, 2020

CONTENTS

CHAPTER

ONE

INTRODUCTION

1.1 Purpose of this Document

This is the FoxXO game design document. This document describes in detail the objectives, requirements, and design considerations of the game providing a central location for this information. This is invaluable for understanding the game's scope, planning the project milestones, and creating the games assets.

Anyone who is involved with the game's development is encouraged to read this document and keep a copy handy.

1.2 Scope of the Game

Tic-tac-toe is a game of strategy where two players, X and O, take turns placing their mark in a 3 x 3 gird. The first player to get three marks in a row, column, or diagonal wins the game.

FoxXO is a unique take on the classic game of tic-tac-toe. Players of all ages battle the computer or each other in a variety of stunning environments. Each environment tells part of the story of tic-tac-toe from the past, present, and future. Each environment has a strong visual theme and complementary soundtrack.

FoxXO is free, open source, and no contains no annoying advertisements. It runs on Windows, Mac, and Linux. The game launches Summer 2020.

1.3 Overview of this Document

This game design document contains chapters covering various aspects of the game.[1] This includes chapters for the *Gameplay*, *User Interface*, and various *Environments*.

The *Technical Design* chapter describe how the game is created. This includes details of the game's software architecture and design.

Additionally, the *Glossary* defines terms that are used throughout the game design document.

[1] The structure of this document is based on [Rogers-2014].

1.4 Project Objectives

This section describes the project's primary objectives.

1.4.1 Create Tic-tac-toe Game with Rust

The main deliverable of this project is a tic-tac-toe game for Windows, Mac, and Linux. This project is the follow-up to the Ounce of Rust project[2]that resulted in the creation of a Rust based tic-tac-toe logic library, `open_ttt_lib`.[4]

In addition to creating a fun game, the project provides more hands on experience using Rust and is a showcase for `open_ttt_lib`.

1.4.2 Provide Free of Charge and Under an Open Source License

FoxXO is and will always be free, open source, and contain no advertisements or trackers. The game is released under a permissive open source license and its code is available from a public repository such as https://github.com/.

Many of today's games casual games are released for free, but include questionable monetization models such as microtransactions, pay-to-win schemes, advertisements, and personal data harvesters. FoxXO stands apart from these games by respecting players who choose to spend their valuable time playing the game.

1.4.3 Release by RustConf 2020

FoxXO's initial release is scheduled to coincide with RustConf 2020 on August 21, 2020.[5] RustConf is the annual Rust developers conference; since FoxXO is developed in Rust this makes an excellent time to launch a Rust based game.[6]

1.4.4 Easily Expandable and Modifiable

Playing tic-tac-toe in a variety of environments is a large part of what sets FoxXO apart from other tic-tac-toe games. The game is designed such that developers can easily add new environments. This allows developers to focus their time and effort creating stunning environments. Additionally, this lowers the barrier of entry for users who are interested in modifying the game. Finally, an easily modifiable code base allows quick turnaround of future releases of the game.

1.4.5 Build Risk Reduction Prototype

The development team creating FoxXO is new to the Rust programming language and the available Rust libraries for game development. To help mitigate this risk, a throwaway prototype game is created early in the project that explores various technical aspects.

Using the lessons learned from the prototype also helps the development team design a code base that is easily expandable and modifiable per the above objective.

[2] For details on the Ounce of Rust project see the Ounce of Rust Project Manual[3]

[3] https://j-richey.github.io/project-documentation/ounce-of-rust/

[4] `open_ttt_lib` is available at https://crates.io/crates/open_ttt_lib and source code is hosted at https://github.com/j-richey/open_ttt_lib

[5] For details on RustConf see their website: https://rustconf.com/

[6] To help meet the target release date, the initial release of the game might contain a subset of the environments described in this document.

CHAPTER

TWO

GAMEPLAY

2.1 Rules of Tic-tac-toe

Tic-tac-toe is a game of strategy where two players, X and O, take turns placing their mark in a 3 x 3 gird. The rules for tic-tac-toe used for each game mode are as follows:

1. Play occurs on a board composed of a 3 x 3 grid of squares. The board starts empty with no marks.
2. The first player places their mark in one of the grid's squares. Traditionally, the mark is the letter *X*.
3. The second player places their mark in one of the grid's empty squares. A square that already contains a mark cannot be updated or altered. Traditionally, the second player uses the letter *O* as their mark.
4. Turns alternate between the players until the game is over.
5. The first player to get three of their marks in a line wins the game. That is: they have three marks in a row, column, or diagonally. Examples of winning games are shown in Figure 2.1.

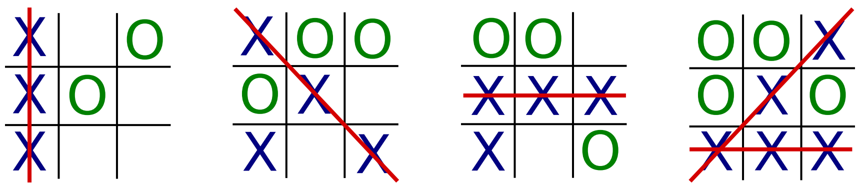


Figure 2.1: Examples of winning tic-tac-toe games showing player X winning by getting three marks a row, diagonal, and column. The red line shows the squares that contributed to the win. Notice that it is possible to get multiple sets of three marks in a row.

6. The game ends in a draw, known as a cat's game, if no more empty squares remain and a player has failed to get three marks in a line. Examples of cat's games are shown in Figure 2.2.

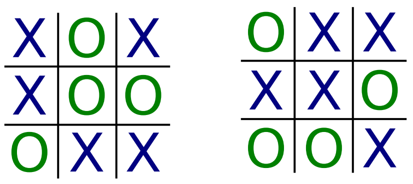


Figure 2.2: Examples of tic-tac-toe games ending in a cat's game. No player managed to get three marks in a line.

7. The steps above are repeated for a series of games. The starting player alternates between games. For example, the second game player *O* gets to make the first move.

2.2 Single-player Mode

In single-player mode the player battles a computer controlled opponent. There are three difficulty settings: **easy**, **medium**, and **hard**.

Easy difficulty is targeted at players who are new to tic-tac-toe and/or computer games. The computer picks random squares allowing players to learn the game's controls and rules.

Medium difficulty is for players who have some experience with tic-tac-toe. The computer provides a challenge to the player but games are still winnable.

At hard difficulty the computer plays almost perfect games. The player must capitalize on rare mistakes made by the computer to win. This is the recommended difficulty for experienced tic-tac-toe players.

2.3 Two Player Mode

In two player mode two players take turns placing their marks according to the rules of tic-tac-toe previously described.

2.4 Speedrun Mode

A speedrun mode provides an additional challenge for experienced players. Players battle a flawless computer opponent through ten environments completing the games as fast as possible. At the end of the run the total time is displayed along with the previous best times.[7]

The player is disqualified and the run halted if the player loses a game. Since the computer opponent never makes a mistake, each game in the speedrun ends in a cat's game. In other words, each speedrun requires the same total number of moves to complete.

Unnecessary animations are disabled in speedrun mode so they do not get in the way of the speedup gameplay. Additionally, speedrun mode has its own dramatic music that replaces the music tracks of each environment — environments are played so fast there is not sufficient time to appreciate their individual sound tracks.

[7] The time it takes the computer to pick a square is not counted towards the player's time. This ensures times are consistent between slower and faster computers.

CHAPTER

THREE

USER INTERFACE

This chapter describes the user interface of FoxXO. This includes the main game board, controls, and all game menus.

3.1 Game Board

The game board is where players spend the majority of their time. Additionally, the game loads directly to this view ensuring players get to gameplay as quickly as possible without menus getting in the way.[8] A concept drawing of the game board is shown in Figure 3.1.

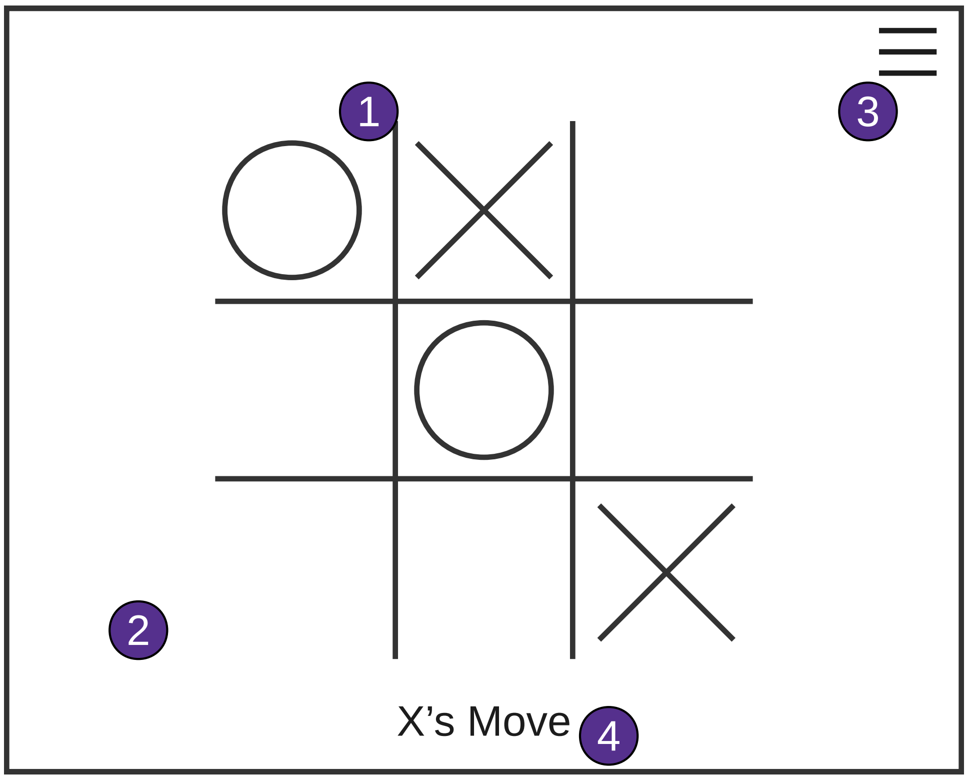


Figure 3.1: Game board concept drawing.

The game board contains the following items of interest:

[8] The loaded game is a single-player game using the last difficulty and player mark settings. The defaults for these are Medium difficulty and X marks.

1. The marks and grid. The appearance of these depend on the current environment being played. However, the marks for all environments use the same center point and have the same selectable hot spot. This ensures consistency between environments when using the mouse.
2. The background of the game board depends on the current environment.
3. The hamburger button opens the *Main Menu*.
4. Status text indicates who gets to make the next move and the outcome of the game. Once the game is over buttons to play the next game or return to the menu also appear in this area. The text is outlined or shaded such that it is visible over any possible background.

A major focus of the game is playing tic-tac-toe in variety of stunning environments that control how the marks, grid, and background look. Thus, a minimalist approach is used for the game board view. The only UI widgets are a menu button and some status text.

3.1.1 Speedrun

Additional UI widgets are added to the game board to facilitate speedrun mode. Figure 3.2 shows the speedrun game board.

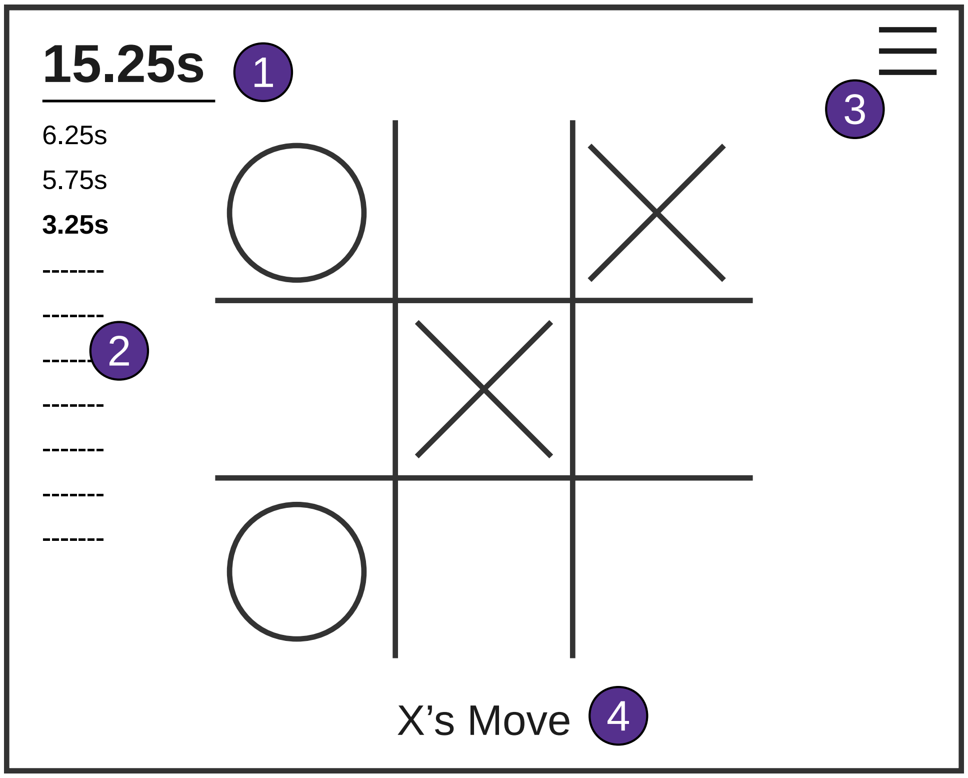


Figure 3.2: Speedrun game board concept drawing.

Items of interest are:

1. The speedrun status display prominently shows the elapsed time of the run. This helps give the player a sense of urgency and lets them see if they are on track to get a best time.
2. Splits for each game are additionally displayed. Dashes or other marks are used for games that have yet to be played. This allows players to quickly visually gauge how many games remain.
3. Opening the game's menu ends the run. The run is disqualified.

4. Status text indicates the current turn. If the player loses a game, the status text notes that the run is disqualified and the player is invited to try the run again or return to the Speedrun menu.[9]

When a game is competed successfully the next game starts immediately allowing players to go as fast as possible through the games.

3.2 Controls

The game can be fully played with either a mouse or keyboard. New or casual players may prefer to use a mouse whereas speedrun players may prefer to use the keyboard.

3.2.1 Mouse

Mouse left click is used to select free squares and press menu buttons. Right click and other mouse buttons are unused.

3.2.2 Key Bindings

The game supports being played using the keyboard. Figure 3.3 shows the game's keybindings for selecting squares.

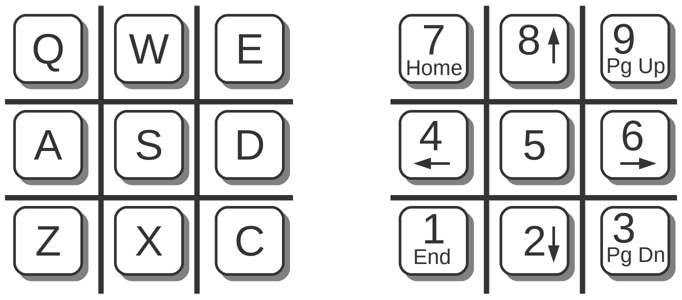


Figure 3.3: Keybindings for selecting squares.

The `numpad` keys are available for right handed players and the `QWE` set of keys are available for left handed players.

The `arrow`, `ESC`, `Enter`, and `Space` keys allow users to navigate the game's menus.

3.3 Menus

The game's menus allow players to select the various game modes and to customize the game. The *Screen Flowchart* provides details on how the menus and views connect.

Each menu is described in the following sections.

[9] If the player loses a speedrun game, the board remains visible so the player can see where they made mistakes. This allows them to adjust their strategy for next time.

3.3.1 General

Unless otherwise noted, the information in this section applies to all menus.

A dedicated music track is played while the game menus are open. The menus share a stylized background that fits in with the game's theme.

3.3.2 Main Menu

The main menu provides a central point for users to navigate to the game's various modes and settings. Figure 3.4 shows the main menu.

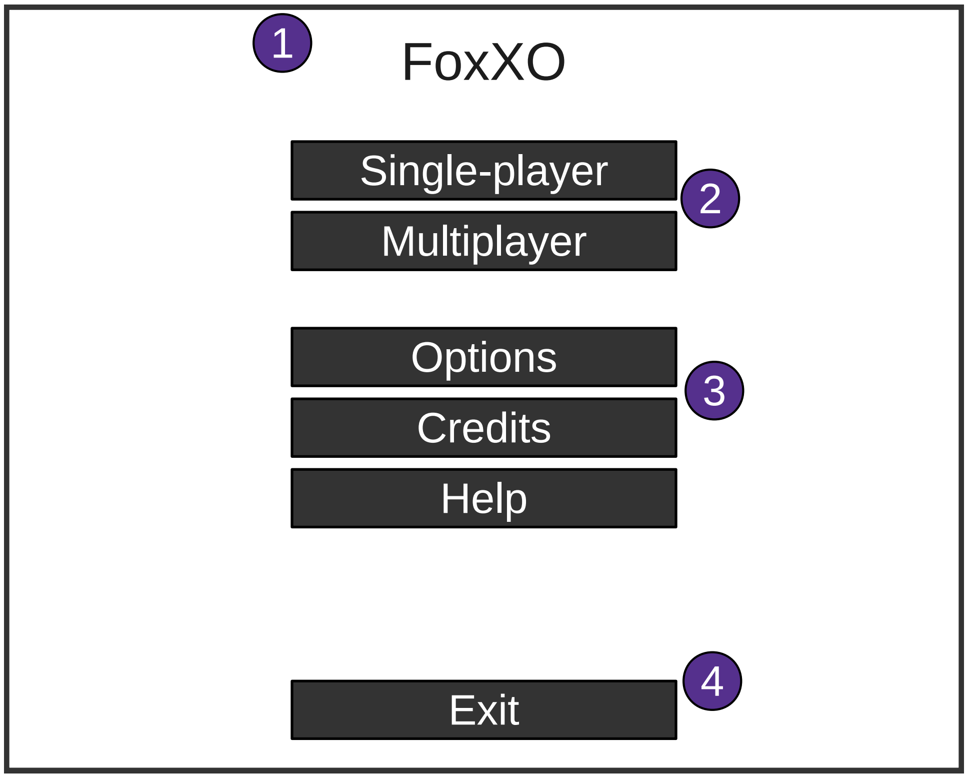


Figure 3.4: Main menu concept drawing.

1. The title of the game is prominently displayed at the top of the menu.
2. New game buttons. The **Single-player** button navigates to the while the *Single-player* screen while the **Multiplayer** button immediately starts a new multiplayer game.[10]
3. Miscellaneous buttons to open the *Options*, *Credits*, *Help* screens.
4. **Exit** closes the game and returns the user to their desktop.

[10] Many games a have a *resume game* button to go back to an progress game. However, tic-tac-toe games are very short and require little pre-game configuration. Therefore, having resume game functionality adds unnecessary complexity for this game.

3.3.3 Single-player

The single-player menu, shown in Figure 3.5, allows players start new single-player games.

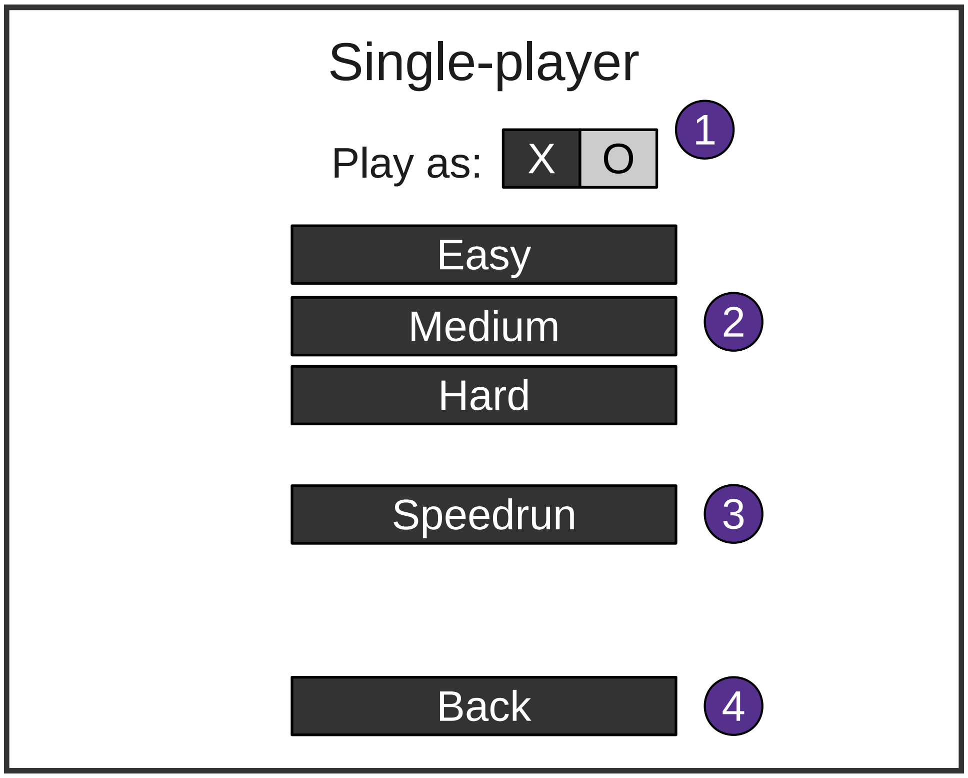


Figure 3.5: Single-player menu concept drawing.

1. The **Play as** selector allows players to select the mark they wish to use throughout the games.
2. The difficulty buttons select the difficulty then start a new single player game. Selecting one of these buttons closes the menu and launches a new single-player game with the requested settings.
3. The **Speedrun** button navigates to the *Speedrun* menu.
4. The **Back** button returns to the main menu.

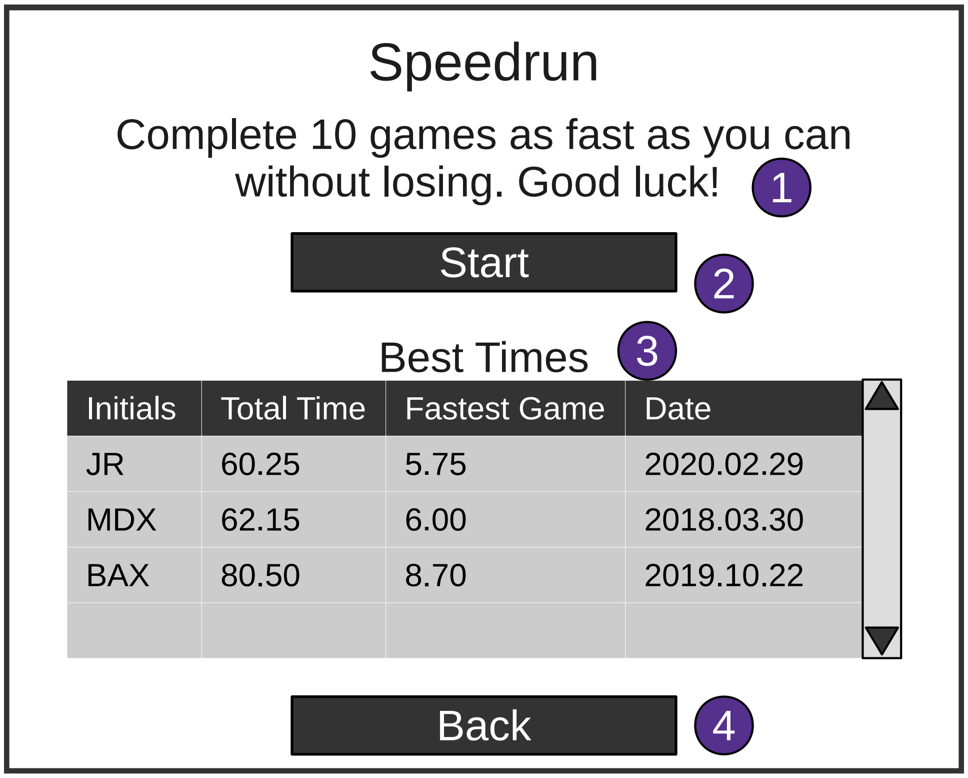
3.3.4 Speedrun

The speedrun menu allows players to start a new speedrun and view best times of previous runs. Figure 3.6 shows the speedrun menu.

The speedrun menu contains the following items of interest:

1. Instructional text that provides a short overview of the speedrun rules. Once the run is completed this text is replaced with the run's result and invites the player to play again.
2. **Start** begins the run. This navigates to the *Speedrun* game board.
3. Table of previous best times sorted from fastest to slowest.
4. The **Back** button returns to the single-player menu.

When the speedrun starts, the game board is shown, a prominent three second countdown begins, and dramatic music starts to swell. Once the timer elapses the speed run begins.


Speedrun
Complete 10 games as fast as you can without losing. Good luck!
1
Start
2
Best Times
3
Back
4

Initials	Total Time	Fastest Game	Date
JR	60.25	5.75	2020.02.29
MDX	62.15	6.00	2018.03.30
BAX	80.50	8.70	2019.10.22

Figure 3.6: Speedrun menu concept drawing.

Once the run is completed the speedrun menu is displayed and shows the result of the run.

If the player gets a new best time the dialog shown in Figure 3.7 is presented to the user.

The best time dialog contains the following items:

1. The speedrun time time.
2. The **Initials** text box allows players to enter their initials so their best time is differentiated from other players that happen to use the same computer. The field remembers the last set of initials entered so players do not have to retype their initials.
3. The **Close** button hides the dialog allowing the speedrun menu to be fully visible.

3.3.5 Options

The options screen contains all of the game's player configurable options. Figure 3.8 shows this screen.

1. **Music Volume** and **Sound FX Volume** sliders to control the volume of these items. This allows players to mute some or all of the in-game sounds.
2. **Reset to Defaults** resets all options to their default values.
3. The **Back** button returns to the main menu.

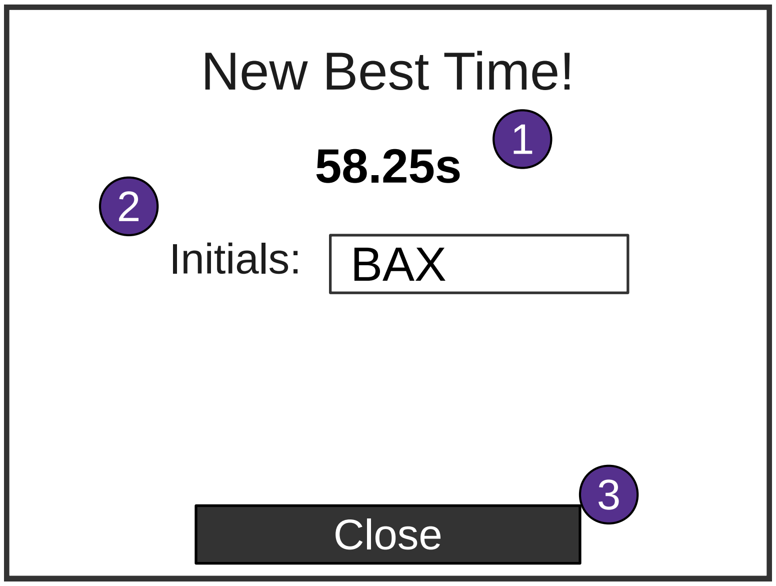


Figure 3.7: Speedrun best time dialog concept drawing.

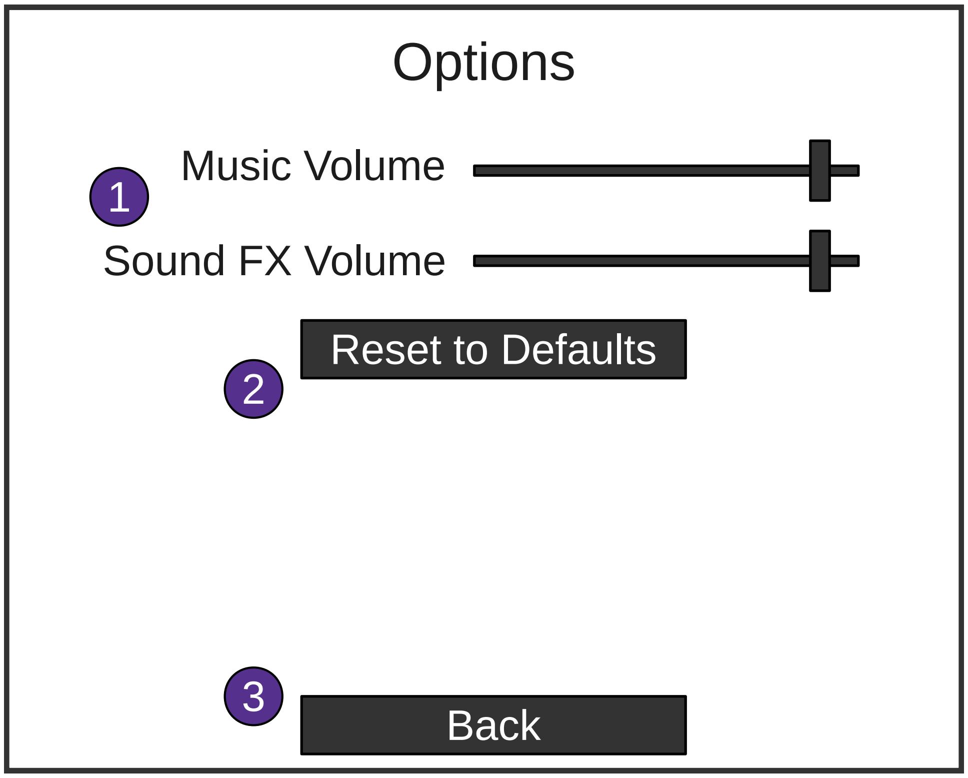


Figure 3.8: Options screen concept drawing.

3.3.6 Credits

The credits screen displays information the game's developers and helps fulfill the *Third Party License Compliance* obligations. The credits screen is shown in Figure 3.9.

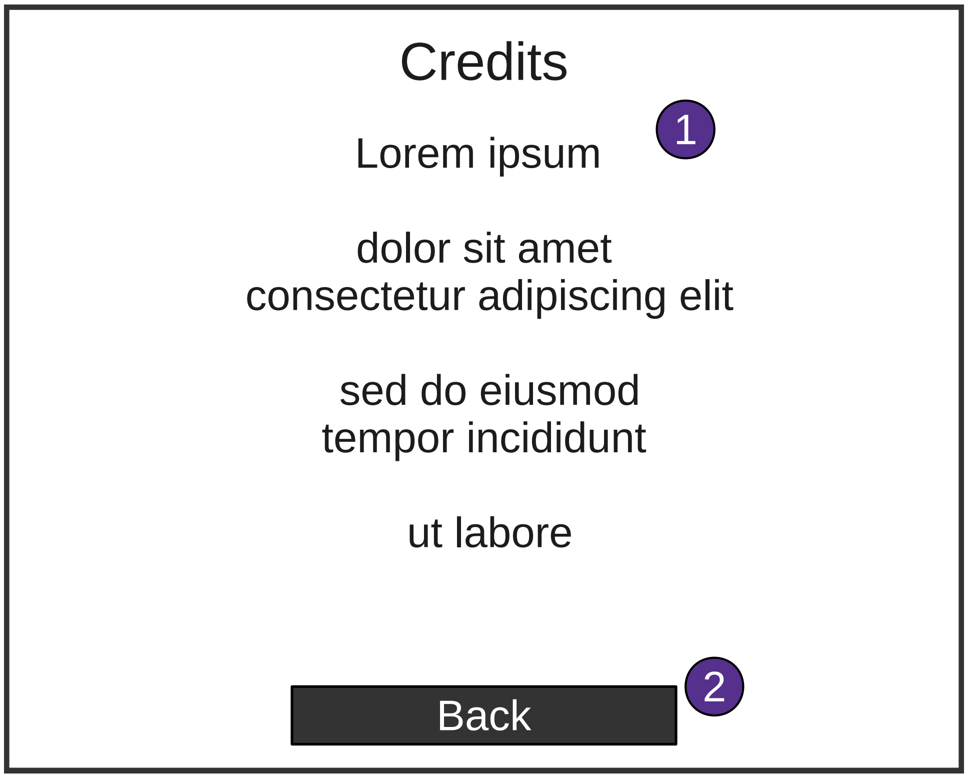


Figure 3.9: Credits screen concept drawing.

The credits screen contains the following items:

1. Scrolling list of developer names, third party assets, and other information about the game.
2. **Back** returns to the *Main Menu*.

The credits screen uses a different background and soundtrack than the other menus. The background consists of one or more tic-tac-toe games being played in a variety of environments. Each environment is clearly visible — blurring and other effects are not used on this screen. The environments are changed several times per game. This showcases the many environments of the game.

The credits screen has its own sound track. The music and sound FX of the individual environments are not used.

Once all of the credits have played the screen remains open with tic-tac-toe games being played in the background.

3.3.7 Loading Screen

If necessary for technical reasons, the loading screen provides feedback to the player while assets are loaded.[11] This screen is only shown when the game first loads.

3.3.8 Help

The game's help provides information on how to play tic-tac-toe, the different game modes, the application version, how to report bugs, and other information. To minimize the complexity of the game's menus, the help is displayed using the user's default web browser. All information is hosted locally; no internet access is required.[12]

3.4 Screen Flowchart

The flow chart in Figure 3.10 visually shows how the screens and menus are connected.

[11] The loading screen is needed if the load time exceeds one second on the minimum supported system listed in Table 5.1.

[12] The *Provide Free of Charge and Under an Open Source License* objective mentions not tracking players. Websites often contain trackers, advertisements, and other items that violate this objective.

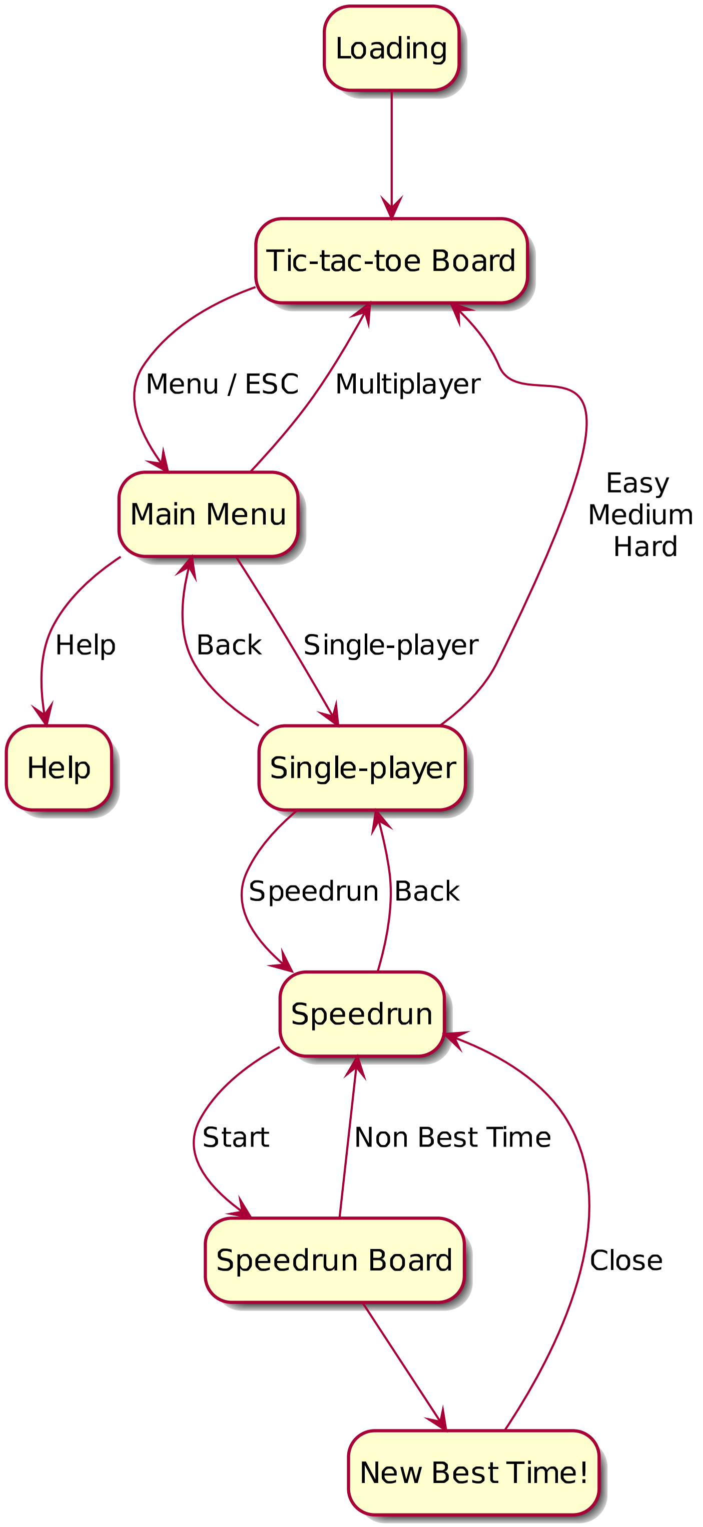


Figure 3.10: Connections between FoxXO's menus and screens.

CHAPTER

FOUR

ENVIRONMENTS

One of the main defining features of FoxXO over other tic-tac-toe games is the use of multiple environments. Each environment has a strong visual theme and complementary soundtrack.[13]

4.1 Environment Selection

Each game takes place on a different environment. Environments are selected using a shuffling algorithm.[14]This ensures players get to experience each environment in a random order.

4.2 List of Environments

4.2.1 Blueprint

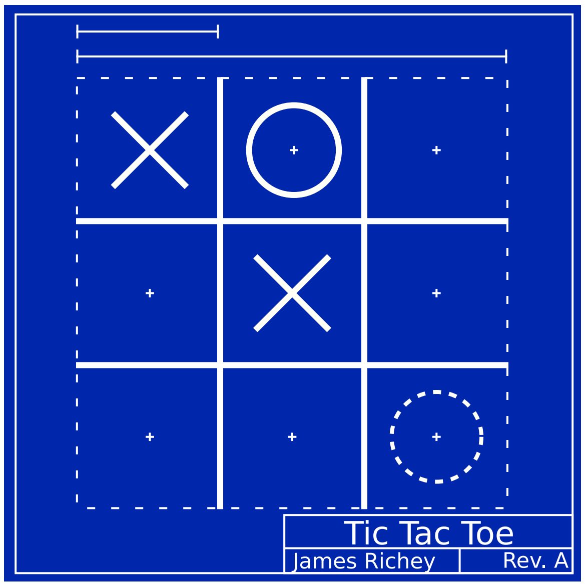


Figure 4.1: Concept art for the Blueprint environment.

[13] To play off of the game's name, FoxXO, environment artists are encouraged to hid a reference to a fox someplace in the environment.
[14] Wikipedia's Fisher–Yates shuffle[15] article contains details on various shuffling algorithms.
[15] https://en.wikipedia.org/wiki/Fisher%E2%80%93Yates_shuffle

Marks and Grid

The blueprint uses white text for the marks and white lines for the grid.

The grid is a series of empty boxes. The interior lines are more prominent than the exterior lines.

Hovering over an empty square shows a dotted version of the mark that would be drawn. Clicking places the mark without further animation.

Winning the game causes a “Winning Marks” label to be placed with arrows pointing to the corresponding marks.

Background Scenery

The background is predominantly deep blue. Additional, details are included in white.

There is a title block with the game’s name, author, version number, etc.

Measurement lines indicate the unit less distance between features.

The grid, squares, marks, etc are pointed to by arrows with labels. Additional notes describe the music being played or point out the key bindings.

Music Theme

Background or thinking music.

Additional Details

This environment provides an opportunity to point out features of the game that might be overlooked by players such as keyboard support.

4.2.2 Notebook Paper and Pencil

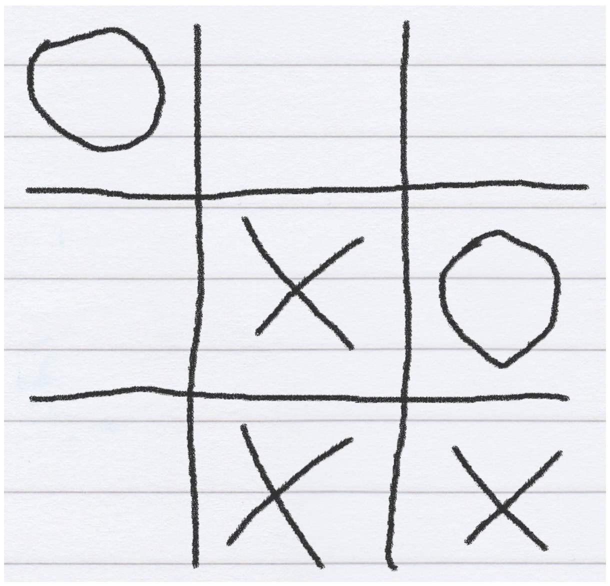


Figure 4.2: Concept art for the Notebook Paper and Pencil environment.

Marks and Grid

The marks and grid are dark graphite from a #2 pencil. Each mark is slightly different and the grid lines are not perfectly straight to give it a hand drawn look. Likewise, mark placement is animated like one writing an X or O while a corresponding pencil sound FX is played.

A line is drawn through the winning marks.

Background Scenery

The background consists of notebook or engineering paper. Notebook paper is white with gray or blue lines. Often times there also a vertical red margin line. Engineering paper is yellow with gray grid lines.

There are doodles, text, or other drawings to give the environment character. The engineering paper is more likely to have nerdy drawings.

Music Theme

Mild background music.

4.2.3 Pen on Scrap Paper

Marks and Grid

The marks and grid are created from blue or red ink. Like the *Notebook Paper and Pencil* environment, each mark is hand drawn with corresponding animations and sound FX.

A line is drawn through the winning marks.

Background Scenery

Various bits of scrap paper are used for the background. This can include but is not limited to bank deposit slip, various store receipts, or any other paper someone might have in their purse.

Text on the paper should be gray, faded black, or otherwise not interfere with the visibility of the marks.

Music Theme

Something with a gospel / church vibe

Additional Details

The mark / grid color and the background image is randomly selected each time the environment is played. Blue and red ink is used so the marks stand out from the background.

The inspiration from this environment comes from me not paying attention in church and drawing on scrap paper my mom happened to have.

4.2.4 Neon Lights

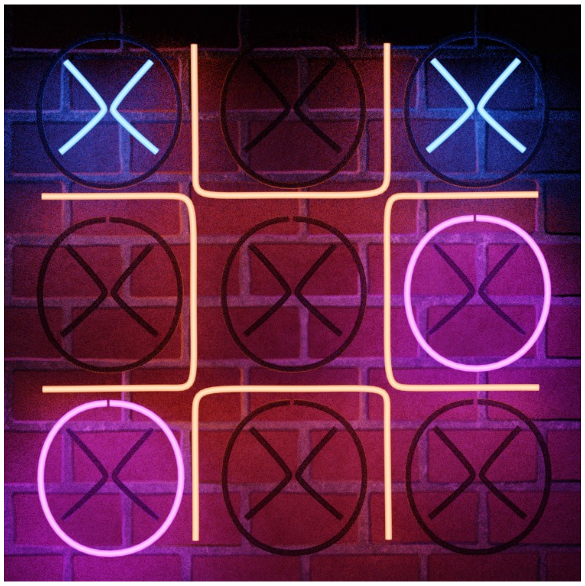


Figure 4.3: Concept art for the Neon Lights environment.

Marks and Grid

The marks and grid are created from luminescent orange, pink and / or blue neon lights. Selecting a square causes the mark to illuminate with a flickering animation and an electric buzzing sound FX.

All winning marks flash on and off with a mild electric buzz sound FX.

When the environment first loads in non-speedrun mode the lights are not illuminated. Then the grid flickers on as if the transformer is starting to fail.

Background Scenery

The background is a brick wall holding the neon lights. The wall is illuminated by the lights. E.g. when a mark is selected the brick wall behind the mark gains some illumination as shown in the concept art.

Music Theme

80’s electronic

Additional Details

This environment provides an opportunity to show off the game's graphics including lighting FX.

4.2.5 Early Computer

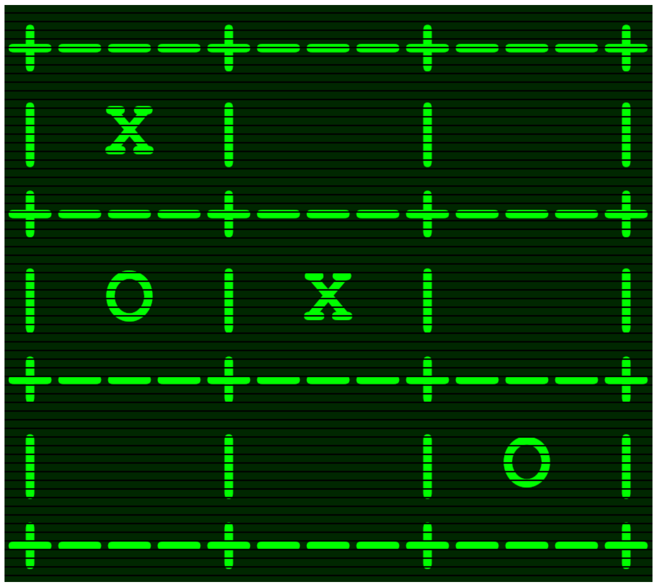


Figure 4.4: Concept art for the Early Computer environment.

Marks and Grid

The marks and grid are green or amber ASCII characters displayed on a low resolution monochrome computer screen. E.g. individual pixels are distinguishable. The marks in winning squares blink on and off.

A blinking cursor is shown when players mouse hover over a empty squares. The cursor is the full width and height of a character, e.g like the modern insert cursor. A cliché beeping sound FX is played when squares are placed.

When the environment loads in non-speedrun mode each line of ASCII text is drawn as if the game was being loaded over a 300 baud modem.

Background Scenery

The background is a monochrome computer monitor with the an off white bezel and red LED near the power button. The background color is dark green or dark amber with perhaps the dark pixels still visible.

Music Theme

8-bit electronic

Additional Details

Additional FX include animated scan lines due to a poor connection between the monitor and computer.

4.2.6 Sidewalk

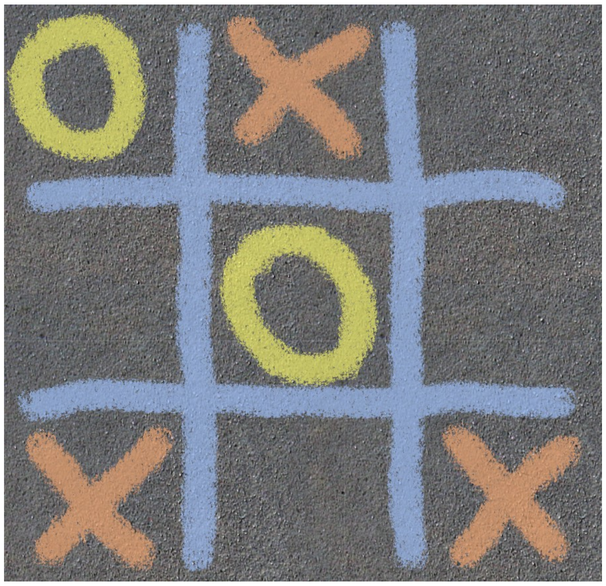


Figure 4.5: Concept art for the Sidewalk environment.

Marks and Grid

The marks and grid are created from pastel sidewalk chalk. The lines are thick and hand drawn with similar animations as the *Notebook Paper and Pencil* environment.

Pastel colors include red, blue, yellow, pink, green, and orange. The X, O, and grid use different colors that are randomly selected each game.

A line is drawn through the winning squares.

Background Scenery

The background is a gray sidewalk or black asphalt. Imperfections such as cracks and twigs are visible. There might even be bits of other chalk drawings visible.

Music Theme

Hip Hob / R&B

4.2.7 Papyrus Paper and Fancy Calligraphy

Marks and Grid

The marks and grid are drawn from a quill pen with deliberate, fancy strokes. Thick black ink is used. The grind lines and marks are precise but the stroke pressure varies as the mark is being made, thus the lines are thinner near the starting and ending points.

Creating of the marks and grid are animated. A line is drawn through the winning squares.

Background Scenery

The marks and grid are drawn on a faded tan papyrus paper. The paper's rough texture is clearly visible.

The tic-tac-toe game could be part of a scroll or book. E.g. there is Latin text and one of those fancy first characters of the paragraph.

Music Theme

Snooty classical music.

4.2.8 Bathroom Stall

Marks and Grid

The marks and grid are scratched into the bathroom stall divider. This reveals the metal underneath the paint. Each scratch is a fairly straight line but it takes several attempts to form a line thus there are "whiskers" hanging off the lines. The O marks are especially problematic resulting in malformed O's.

A metal scraping sound FX is played when the marks are being created.

A line is scratched through the winning marks.

Background Scenery

The background is a pail blue, green, or gray stall divider. There is additional graffiti written in ink or scratched into the paint that one would find in a truck stop bathroom. Nothing inappropriate but adults should find it funny.

Music Theme

Truck stop music; perhaps a country vibe.

Additional Details

There is bathroom humor a Easter egg in this environment. A "straining" sound FX is played after a minute or two; past the length of a typical game. Think of that one scene from Austin Powers. The situation becomes more desperate as time goes on. Finally it resolves itself with a large plop / splash sound and a big sigh of relief.

4.2.9 Chalkboard

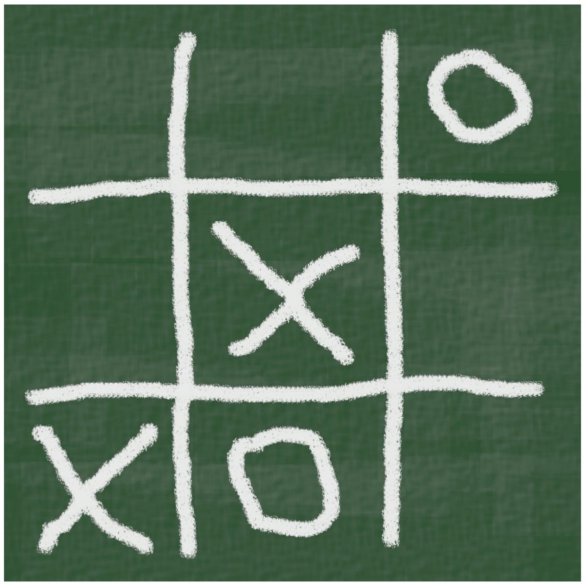


Figure 4.6: Concept art for the Chalkboard environment.

Marks and Grid

The marks and grid are created from hand drawn white chalk. A stereotypical chalk sound FX is used when the marks are being drawn.

A line is drawn through winning marks.

Background Scenery

A black or dark green chalkboard is used as the background. The chalkboard is well used; there is a lot of chalk dust marks left from the eraser.

To reinforce the chalkboard theme, the tray containing the eraser and extra chalk is visible.

Music Theme

To be determined later by the environment artist.

4.2.10 Whiteboard

Marks and Grid

The marks and grid are created from various colors of dry erase markers. Typical colors include, blue, green, black, red, and purple. The grid and each mark are hand drawn in different colors.

A squeaking sound is made when marks are being drawn.

Winning marks are circled to both give a more professional look to the environment and differentiate it from the chalkboard environment.

Background Scenery

The background is a white dry erase board. The board does not erase well so faded physics equations is still visible in the background.

To reinforce the whiteboard theme, the tray containing the eraser and extra markers is visible.

Music Theme

To be determined later by the environment artist.

Additional Details

Easter egg opportunity: selecting one of the extra markers changes the mark color of the current player.

4.2.11 Ancient Alien Ruins

Marks and Grid

The marks and lines are glyphs carved into rock with glowing light coming from the glyphs.

At first there is a grid, X, and O carvings in the rock. Mouse hovering over a free square causes some mild blue illumination. Placing the mark results in brighter illumination and the surrounding grid to illuminate too.

When the game ends in a win, the wining marks illuminate very brightly and even change color. The grid takes on a uniform illumination. A cats game or single player loss results in the grid to go dark and all the marks to go back to a mild illumination, as if the power has been cut and they are slowly fading away.

A strange alien sound FX is used when marks are placed.

Background Scenery

The background is gray rock that would be found in a cave deep in the jungle. There are various glyphs carved into the rock. There might even be some moss, vines, or other deep green plants on the rock.

Music Theme

SciFi

4.2.12 Dirty Car Window

Marks and Grid

The marks and grid are drawn in the window's dust reviling the shiny tinted glass underneath. The marks are fairly fat and despite being hand drawn are mostly straight.

A mild swooshing sound FX is used when marks are drawn. A line is used to indicate wining marks.

Background Scenery

The background is a dusty car window. The dust is a brown dirt color. Stickers such as the "my family" are trying to peak out from underneath the dust. The back windshield wiper reinforces the car theme.

Music Theme

Hip Hop with rattling door sounds.

4.2.13 16x4 LCD Display

Marks and Grid

The marks and grid are black or white LCD pixels. Black is used with the green background and white is used with the blue background.

Mousing over a free location causes a cursor, the underscore character (_), to blink in that location.

Asterisk characters are placed next to winning marks.

Background Scenery

The background is green or blue backlit 16x4 LCD display that is mounted on a green circuit board. There are other electrical components, wires, and even LEDs around.

Music Theme

8 bit

Additional Details

Some artistic liberty with regards to the 16x4 LCD display might need to occur to ensure the mark's center points are in the correct locations.

4.2.14 Ancient Egypt Tomb

Marks and Grid

The marks and grid are carved into the limestone wall background. A chiseling sound FX is played when marks are being carved. The grid and marks are chiseled with skill, that is they are straight and precise.

A line is chiseled through the winning marks.

Background Scenery

A limestone wall covered in hieroglyphs is used as the background.

Music Theme

Something with an ancient vibe.

4.2.15 Beach

Marks and Grid

The marks and grid are hand drawn into sand at the beach. A light swooshing sound FX is played when marks are created.

A line is drawn through the winning marks.

Background Scenery

Wet stand is used as the background. There are seashells and other shore debris.

Music Theme

Tropical / Jamaican / steal drums.

4.2.16 RGB Led Grid

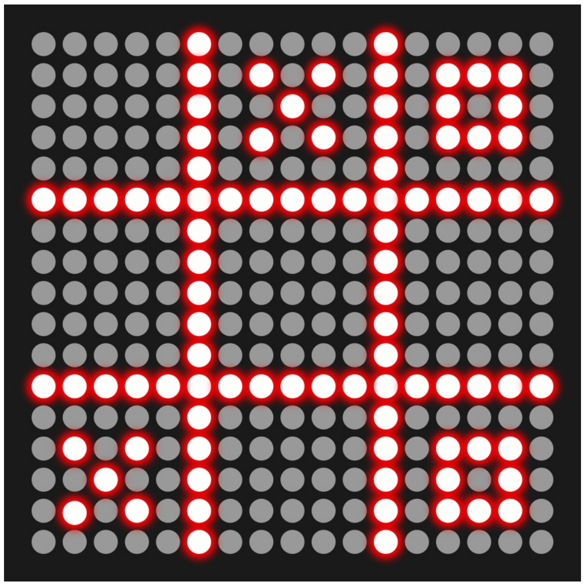


Figure 4.7: Concept art for the RGB Led Grid environment.

Marks and Grid

The marks and grid are displayed on a 64x32 RGB LED grid. The marks and grid each use their own colors. This includes primary and secondary colors.

Placing a mark displays an cheesy animation such as stacking up block to form the mark. Winning squares flash between normal and inverted color where the background is illuminated instead of the foreground.

Background Scenery

The background is the unilluminated LEDs and the plastic material that separates the LEDs. The LEDs are a lighter color than the almost black spacer material. Occasionally there may be various animations or other FXs played on the LEDs outside the play area.

Music Theme

Modern 8 bit or techno.

4.2.17 Electroluminescence

Marks and Grid

The marks and grid are composed of either cyan or orange colored electroluminescent wire. X is assigned one color, and O the other. Placing a mark causes the border of the grid to pick up the marks color.

All of the marks and grid take on the winner’s color after a brief flashing transition.

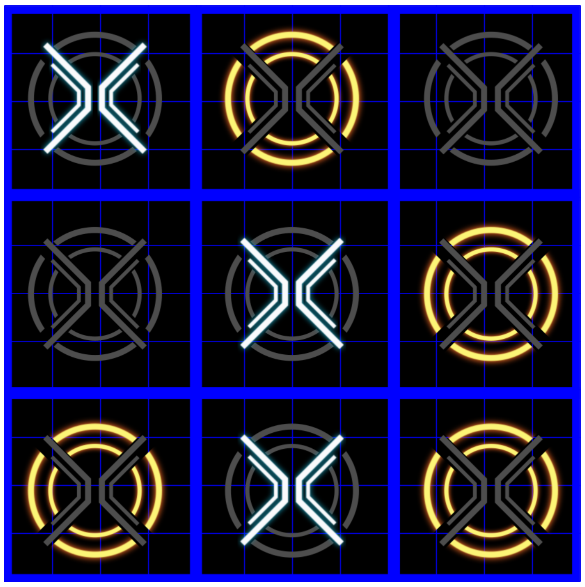


Figure 4.8: Concept art for the Electroluminescence environment.

Background Scenery

Black with a faint blue or cyan grid pattern. Pulses of light could occasionally travel down the grids.

Music Theme

Techno

4.2.18 Crayon

Marks and Grid

The marks and grid are hand drawn with different colors of crayons.

A line is drawn through the winning marks.

Background Scenery

The game is played on drywall. A light switch or electrical outlet is visible to reinforce the location. There are other rudimentary drawings of flowers, houses, or trucks visible.

Music Theme

To be determined later by the environment artist.

4.2.19 Oil Painting

Marks and Grid

Thick oil based paint forms the marks and grid. The brush strokes are clearly visible. Strokes are deliberate resulting in fairly straight lines. Stereotypical paint stroke FXs are used where lines from individual bristles are visible as the stroke is letting up.

Various vibrant colors are used; the marks and grid each get their own color.

A line is drawn through the winning squares.

Background Scenery

The painting is being drawn on white canvas. The texture is clearly visible. Part of the wooden easel is also visible.

Music Theme

Phone hold music, e.g. light modern classical.

4.2.20 Bacteria

Marks and Grid

The grid is composed of rod bacteria viewed under a microscope. The X and O marks are likewise formed from bacteria of the corresponding shape.

The bacteria can appear purple in color due to Gram staining or as red.

The winning squares are marked by the bacteria inside the multiplying rapidly.

Background Scenery

The background is the fluid the bacteria is living in. There are imperfections in the fluid that seem to wander around, many out of focus.

Music Theme

To be determined later by the environment artist.

4.2.21 App

Marks and Grid

The marks and grid are made up of simple clean lines. The marks are solid red or blue. The grid is solid gray in color. Animations are not used or used lightly.

A line is drawn through the winning marks. The line is the same color as the marks.

Background Scenery

The game is being played on a smart phone that is rotated 90 degrees. The background of the play area is solid white.

Additionally. the phone's bezel, speaker, and status bar are all visible. The status bar includes signal level, power level, and time on the right side. The left contains annoying advertisements that advertise fictional products, poke fun at data stealing apps, and promote the other environments in the game. The advertisements are rotated 90 degrees like the phone.

Music Theme

Casual

Additional Details

There is an Easter egg opportunity with the advertisements where clicking on one advertising a different level switches the environment to that level.

CHAPTER

FIVE

ADDITIONAL CONSIDERATIONS

This chapter contains additional information about FoxXO.

5.1 Target Audience

FoxXO is targeted at casual gamers. There are three general groups that might find the game interesting: new PC gamers, bored adults, and modders.

5.1.1 New PC Gamers

FoxXO can be played by young or older players that do not have much PC gaming experience. The game requires basic strategy and has simple inputs. As players become more comfortable with the game mechanics they can try *Speedrun Mode*.

5.1.2 Players Filling Time

Office workers or people stuck on an airplane can play FoxXO to make the time pass. The regular game modes do not demand much attention so players can let their minds wonder while playing. The variety of environments should keep players entertained for at least a little while.

5.1.3 Computer Science Students / Modders

FoxXO is open source and is developed so that others can add their own environments or extend the game. FoxXO is a simple, but non-trivial application where people learning to program might find it an interesting code base to examine.

5.2 Target Platforms

FoxXO runs on a variety of popular desktop operating systems including Windows, macOS, and Linux. Being a casual game, it does not require a beefy video card or fast processor. Table 5.1 lists the minimum system requirements.

Table 5.1: FoxXO minimum system requirements

OS	Windows 10, Linux[16], macOS
Processor	1GHz dual core
RAM	4GB
Disk	500 MB available space
Graphics	OpenGL compatible graphics adapter
Display	800 x 600 pixel display or larger
Network	The game is played fully offline

A system with the above requirements listed in Table 5.1 can render the game at an average of at least 30 frames per second.

5.3 Licensing and Distribution

This section describes how the game is licensed, distributed, and other related details of getting the game into player's hands.

5.3.1 Game's License

The game is dual licensed under the MIT[17]and Apache-2.0[19]licenses. This is the same licensing scheme used for the Rust language.[21]Under these licenses users are free to obtain, modify, and redistribute the source code for both private and commercial use.

Any original game assets are licensed under the CC-BY-4.0 license.[23]

5.3.2 Distribution

The game is directly distributed to players via the internet. There are two main ways to acquire a copy of the game: downloading a platform specific package, or building the game from source.

Platform Packages

Platform specific packages can be downloaded from the game's website. In particular, Windows users expect an installer to install the game on their system. They do not have ready access to compilers or other tools to build software from source. Finally, Windows is the most widely used operating system so a Windows installer is a requirement for this project to be successful.

Linux and Mac users have easier access to compilers but they still appreciate packages for their convenience. Packages for these platforms are created on a best effort basis.

[16] FoxXO is tested on the latest releases of Debian and Fedora. It should work on other popular distributions including Ubuntu. However, testing on other distributions is outside the scope of this project.

[17] Choose an open source license - MIT License[18]

[18] https://choosealicense.com/licenses/mit/

[19] Choose an open source license - Apache License 2.0[20]

[20] https://choosealicense.com/licenses/apache-2.0/

[21] See Rust's README[22] for licensing details.

[22] https://github.com/rust-lang/rust#license

[23] Choose an open source license - Creative Commons Attribution 4.0 International[24]

[24] https://choosealicense.com/licenses/cc-by-4.0/

Build from Source

Because the game is open source anyone can build the game from source. This involves cloning the game's source code repository and following the build instructions documented in the README file.[25]

5.3.3 Monetization

There is no intention to generate revenue from FoxXO. The is released free of charge. There are no advertisements, microtransactions, or data stealing spyware that is found in other *free* games.

5.3.4 Third Party License Compliance

FoxXO makes extensive use of third party software libraries and game assets to help reduce the development effort. To use these resources, the game must comply with their various licensing terms. Additionally, the game can only use any third party resources that have licenses that are compatible with the game's license.

Software Libraries

Rust libraries that have the following licenses can be used by the game:

- MIT
- Apache-2.0
- The Unlicense

Additionally, the game can dynamically link to libraries with the above licenses plus libraries that are licensed under the LGPL.

A software bill of materials is included in the game's user documentation. This ensures the game complies with the required copyright notices. Also, users can see exactly what is included in the software.

The software bill of materials includes the following information about each library:

- Name
- Version number
- License
- Link to website or source code repository

Game Assets

The game can freely use or remix third party music, sound FX, and textures that have the following licenses:[26]

- CC0
- CC-BY
- CC-BY-NC[27]

[25] Cargo, the Rust package manager, can download and build applications hosted on crates.io. However, crates.io has a 10MB size limit that is too small to host this game.

[26] The CC-BY-SA is incompatible with the the game's licensing terms. It is this author's understanding that a game is considered a derivative work and thus must also be licensed under CC-BY-SA if it were to use CC-BY-SA assets.

[27] Per the monetization section, the game is being released for free and is not intended to produce a revenue stream.

A list of third party assets used is accessible from the game's credits or user documentation to fulfill the attribution requirements. The following information is included for each asset:

- Title - title of the work.
- Author - name or handle of the author.
- License - the specific CC license the work is published under.
- Copyright notice - some works include a copyright notice supplied by the author that must be included in the attribution.
- Source - link to website the asset was obtained from.
- Is derivative - Mention if the work was modified from the original and provide a short summary of changes.

5.3.5 Internationalization and Localization

The game is initially released in American English. However, localizations are accepted from contributors to include in future releases. This helps the game be more accessible to a wider audience. To make it easy to add various localizations, the game is designed with internationalization support.

5.4 Similar Games

Tic-tac-toe is a popular paper and pencil game that has been played since the times of ancient Egypt. Sandy Douglas' 1952 take on tic-tac-toe, called OXO, was one of the first computer games.[29]

However, the major inspiration for this variant of tic-tac-toe comes from James Richey's 2004 Tic Tac Toe[28] shown in Figure 5.1.

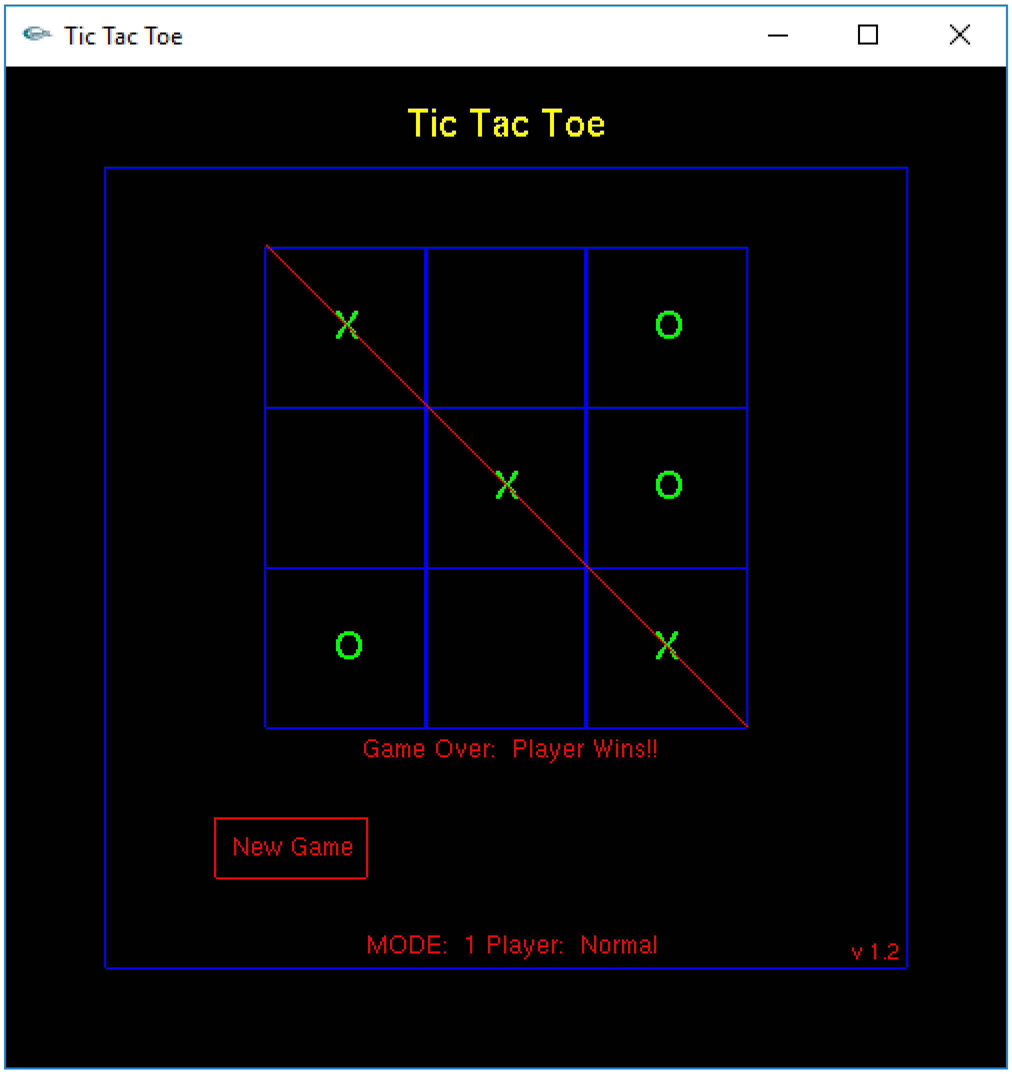
James developed his version of while learning the C++ programming language. Tic-tac-toe provides a fun challenge for learning a new language: it requires both algorithmic and graphical components to implement a small but nontrivial application.

When thinking of a project to use to help learn the Rust programming language, creating a tic-tac-toe game is a fun choice.

5.5 Future Enhancements

There are some additional features that can be considered for future versions of the game. These are described below.

[29] See Wikipedia's Tic-tac-toe[30] article for additional information about the history of tic-tac-toe.
[30] https://en.wikipedia.org/wiki/Tic-tac-toe
[28] https://www.imaginaryphase.com/ttt.html



Game Over: Player Wins!!

MODE: 1 Player: Normal

Figure 5.1: Screen shot of James Richey's 2004 Tic Tac Toe.

5.5.1 Network Multiplayer

Network based multiplayer allows players to remotely battle each other. Network based multiplayer is preferable to local multiplayer in many situations such as friends who live in different states, office environments, or players trying to avoid a zombie apocalypse.[31]

There are different network multiplayer modes.

Normal The normal mode is *Two Player Mode* but played over the network instead of locally.

Speedrun Speedrun multiplayer is a two player version of *Speedrun Mode* where the players compete to see who can play 10 games the fastest without loosing. If a player wins one of the games, the speedrun is over and that player is the winner. If all ten games are cat's games, then the player with the fastest overall time wins.

King of the Hill King of the hill allows more than two people to battle. From the pool of available players two are chosen to battle. The round consists of playing two games. The player first to win any game, or in the case of all cat's games has the fastest overall time, wins the round. They stay in the game and another challenger is selected from the pool of players. This continues until a victory condition is met, such as the first player to win X number of rounds.

Regardless of the mode, the players always see the same environment to ensure a consistent play experience.

5.5.2 Achievements

Achievements provide players goals outside the usual *Gameplay* rules. These provide more depth to the game and encourage players to try different approaches to the game.

A future enhancement is to add achievements to the game. Some achievement might include the following.

- Win a game
- Play a game in every environment
- Win a hard game
- Win a game on every environment
- Win a hard game on every environment
- Complete a speed run
- Complete a speed run in less than X seconds
- Complete a speed run in less than 1 second!!

5.5.3 Additional Environments

A major focus of FoxXO is the ability to play tic-tac-toe in a variety of *Environments*. Future versions of the game can add even more environments. Some environments to consider are listed below.

- Lasers. Perhaps a laser cutter or some other use of lasers.
- Shower door or bathroom mirror.
- Futuristic dystopian or cyber punk theme.
- Some playgrounds have a 3x3 grid of squares for playing tic-tac-toe.
- Winter / snow / frozen lake theme.

[31] 2019–20 coronavirus pandemic[32]

[32] https://en.wikipedia.org/wiki/2019%E2%80%9320_coronavirus_pandemic

- Food theme.
- Light board, like those found in ships or submarines.
- OXO oscilloscope throwback theme.
- Metal or glass forge with lots of glowing hot liquids.
- Clone of James' 2004 Tic Tac Toe.

CHAPTER

SIX

TECHNICAL DESIGN

The technical design of FoxXO is described in this chapter.

Note: The Technical Design chapter is intentionally incomplete in this version of the game design document. This chapter is pending completion of the throwaway prototype so the lessons learned during the prototyping phase can help inform the various design decisions.

6.1 Throwaway Prototype

The throwaway prototype fulfills the *Build Risk Reduction Prototype* objective. The development team is new to the Rust game development ecosystem; the prototype allows us to explore various techniques and come up with a design that fulfills the game requirements listed in this document.

Technical aspects that are explored in the prototyping phase are:

- Buttons, menus, and other GUI components as described in the *User Interface* chapter.
- User input from a mouse and keyboard. Includes determining the location of mouse clicks.
- Camera, scene, and window management. E.g. looking at draw order and window resize behavior.
- Drawing bitmap textures. Many environments make use of textures for their backgrounds.
- Drawing marks and the gird for environments like the *Blueprint* or *Chalkboard*. Perhaps these have lines that could be generated with vector type graphics or bitmaps that follow paths?
- Animations or sprints. Includes ability to adjust animations speed. Many environments animate drawing of the marks or a line through the winning marks.
- Sound FX and music. Includes cross fading between tracks and knowing the length sound FX.
- Lighting, blurring, and other special FX. For example, the *Neon Lights* environment makes heavy use of lighting. Investigate using shaders to power these effects.
- Particle systems. They might make a nice touch to many environments such as sparks when the *Neon Lights* turn on or showing chalk dust from the *Chalkboard*.
- Ability to save and load structured data. This is needed for the user options and speedrun best times.
- Internalization support.
- Run the prototype on Windows, Mac, and Linux to address any platform specific issues.

As the name suggests, the prototype is discarded once the team has explored the technical aspects in question. The prototype is not published to crates.io and platform specific packages are not created for the prototype. Instead, the lessons learned are documented in this chapter so a comprehensive production application can be built.

CHAPTER

SEVEN

GLOSSARY

background music Background music is a type of music that is not intended to be the primary focus of listeners. When described as the type of music for an *environment*, it indicates the environment's music is not a main focus of the environment.

cat's game Term used when a game of tic-tac-toe ends in a draw where there is no winner.

environment An environment is a unique setting or location where tic-tac-toe is played.

hand drawn Hand drawn is a style of line that is wavy and imprecise.

open source software Open source software is software whose source code is available for others to study, modify, and redistribute.

Rust programming language Rust is a systems programming language with a focus on safety and speed. Website: https://www.rust-lang.org/

RustConf RustConf is the annual Rust developers conference.

speedrun A speed run is a play-though of a video game where the go is to complete the game as fast as possible.

throwaway prototype A prototype is a version of software that is created to demonstrate core features or techniques of a software application. A throwaway prototype is discarded once the features or techniques have been demonstrated. Throwaway prototypes allow for rapid experimentation with low risk.

BIBLIOGRAPHY

[Rogers-2014] Scott Rogers (2014) *Level Up! The Guide to Great Video Game Design*.

INDEX