



Bilkent University

Department of Computer Engineering

CS319 Term Project

CS319 1I-TM

Spring 2020

Analysis Report

Team Members

Rafi Çoktalas

Zeynep Cankara

Kamil Gök

Efe Macit

Arda Gültekin

Instructor: Eray Tüzün

Teaching Assistant(s): Alperen Çetin

Contents

1. Introduction	6
2. Overview	6
2.1. Components	6
2.1.1. Gameboard	6
2.1.2. Cult Board	6
2.1.3. Faction Boards	6
2.1.3.1. Transformation Cycle	6
2.1.3.2. Supply	7
2.1.3.3. Depicted Starting Resources	7
2.1.3.4. Bowls of Power	7
2.1.4. Terrains and Structures	7
2.1.5. Power Tokens, Coins, Workers and Priests	7
2.1.6. Scoring Tiles	7
2.1.7. Favor Tiles	7
2.1.8. Bonus Cards	8
2.1.9. Town Tiles	8
2.2. Game setup	8
2.2.1. Setup of the Faction Boards	8
2.2.2. Setup of the Gameboard	8
2.2.3. Setup of the First Structures	8
2.2.4. Choosing of Bonus Cards	8
2.3. Gameplay	9
2.3.1. Phase 1: Income	9
2.3.1.1. Income for Structures	9
2.3.1.2. Income for Cards and Tiles	9
2.3.1.3. Gaining Power	9
2.3.2. Phase 2: Actions	9
2.3.2.1. Transform and Build	9
2.3.2.1.1. Transform	9
2.3.2.1.2. Build	10
2.3.2.2. Advancing on the Shipping Track	10
2.3.2.3. Lowering the Exchange Rate for Spades	10
2.3.2.4. Upgrading a Structure	10
2.3.2.4.1. From Dwelling to Trading House	10
2.3.2.4.2. From Trading House to Stronghold	10

2.3.2.4.3. From Trading House to Temple	10
2.3.2.4.4. From Temple to Sanctuary	10
2.3.2.4.5. Gaining Power via Structures	10
2.3.2.5. Send a Priest to the Order of a Cult	11
2.3.2.6. Power Actions	11
2.3.2.7. Special Actions	11
2.3.2.8. Pass	11
2.3.2.9. Power Bowl Conversions	11
2.3.2.10. Founding a Town	12
2.3.3. Phase 3: Cult Bonuses and Clean-up	12
2.3.3.1. Cult Bonuses	12
2.3.3.2. Return of Action Tokens	12
2.3.3.3. Coins on Bonus Cards	12
2.3.3.4. Turn the Scoring Tile Face Down	12
2.4. End of the Game and Final Scoring	12
2.4.1. Cult Scoring	12
2.4.2. Area Scoring	13
2.4.3. Resource Scoring	13
2.4.4. The Winner(s)	13
2.5. Factions	13
2.5.1. Forest Factions	13
2.5.1.1. Auren	13
2.5.1.1.1. General Ability of Auren	13
2.5.1.1.2. Stronghold Ability of Auren	13
2.5.1.2. Witches	13
2.5.1.2.1. General Ability of Witches	14
2.5.1.2.2. Stronghold Ability of Witches	14
2.5.2. Lakes Factions	14
2.5.2.1. Mermaids	14
2.5.2.1.1. General Ability of Mermaids	14
2.5.2.1.2. Stronghold Ability of Mermaids	14
2.5.2.2. Swarmlings	14
2.5.2.2.1. General Ability of Swarmlings	14
2.5.2.2.2. Stronghold Ability of Swarmlings	14
2.5.3. Swamp Factions	14
2.5.3.1. Alchemists	14
2.5.3.1.1. General Ability of Alchemists	14
2.5.3.1.2. Stronghold Ability of Alchemists	15
2.5.3.2. Darklings	15

2.5.3.2.1. General Ability of Darklings	15
2.5.3.2.2. Stronghold Ability of Darklings	15
2.5.4. Wasteland Factions	15
2.5.4.1. Chaos Magicians	15
2.5.4.1.1. General Ability of Chaos Magicians	15
2.5.4.1.2. Stronghold Ability of Chaos Magicians	15
2.5.4.2. Giants	15
2.5.4.2.1. General Ability of Giants	15
2.5.4.2.2. Stronghold Ability of Giants	15
2.5.5. Plains Factions	16
2.5.5.1. Halflings	16
2.5.5.1.1. General Ability of Halflings	16
2.5.5.1.2. Stronghold Ability of Halflings	16
2.5.5.2. Cultists	16
2.5.5.2.1. General Ability of Cultists	16
2.5.5.2.2. Stronghold Ability of Cultists	16
2.5.6. Desert Factions	16
2.5.6.1. Fakirs	16
2.5.6.1.1. General Ability of Fakirs	16
2.5.6.1.2. Stronghold Ability of Fakirs	16
2.5.6.2. Nomads	16
2.5.6.2.1. General Ability of Nomads	16
2.5.6.2.2. Stronghold Ability of Nomads	17
2.5.7. Mountains Factions	17
2.5.7.1. Engineers	17
2.5.7.1.1. General Ability of Engineers	17
2.5.7.1.2. Stronghold Ability of Engineers	17
2.5.7.2. Dwarves	17
2.5.7.2.1. General Ability of Dwarves	17
2.5.7.2.2. Stronghold Ability of Dwarves	17
2.6. Rules	17
3. Functional requirements	18
3.1. Multiplayer game	18
3.2. Help	18
3.3. Choose a faction	19
3.4. Building Dwellings	19
3.5. Transforming Terrains	19
3.6. Improvements in Faction Abilities	19

3.7. Use of Priests	19
3.8. Power Actions	19
3.9. Special Actions	20
3.10. Upgrading Structures	20
3.11. Power Bowl Conversions	20
4. Nonfunctional requirements	20
4.1. Documentation	20
4.2. Extensibility	20
4.3. Efficiency	20
4.4. Usability	20
5. System models	21
5.1. Use case model	21
5.1.1. Use Case Descriptions	21
5.1.1.1. Name: Choose faction	21
5.1.1.2. Name: Transform terrain	22
5.1.1.3. Name: Build dwelling	22
5.1.1.4. Name: Improve Shipping	23
5.1.1.5. Name: Improve terraforming skills	23
5.1.1.6. Name: Upgrade Structures	23
5.1.1.7. Name: Send priest to cult	24
5.1.1.8. Name: Use power action	24
5.1.1.9. Name: Power bowl conversion	25
5.1.1.10. Name: Convert Power Token from power bowl 2 to 3	25
5.1.1.11. Name: Sacrifice power tokens	25
5.1.1.12. Name: Convert Power Token from power bowl 1 to 2	26
5.1.1.13. Name: Take special action	26
5.1.1.14. Name: Pass	26
5.2. Dynamic models	27
5.2.1. Sequence Diagrams	27
5.2.1.1. Sequence Diagram for Terraforming, Building Dwelling and upgrading a Structure	27
5.2.1.2. Sequence Diagram for converting power tokens	28
5.2.1.3 Sequence Diagram for improving shipping and improving terraforming	28
5.2.1.4 Sequence Diagram for advancing in cult board	29
5.2.2 State Diagrams	29
5.2.2.1 Upgrade Structures State Diagram	29
5.2.3 Activity Diagrams	30

5.2.3.1 Calculating Victory Points	30
5.2.3.2 Gaining Power via Adjacency	31
5.2.3.3 Founding Town	31
5.3. Object and class model	32
5.4. User interface	34
5.4.1. Main Menu Mockup Screen	34
5.4.2. Game Board Screen (4 Players)	35
5.4.3. Player Faction Board	36
5.4.4. Choosing an action	37
6. Improvement Summary	37
7. References	37

Analysis Report

Terra Mystica

1. Introduction

Terra Mystica is a game with a magical world where the terrain is open to alteration. The players aim to improve a faction, which they choose from the existing fourteen factions. Each faction has its own bonus cards, special abilities, terrain boundaries and the map is not big enough for all. Hence, you have to both compete for claiming new territories and change the terrain to sustain your faction. You have to expand your land and build in order to gain important sources like money and power. The way to victory is not unique so that it is possible to beat your rivals in many ways.

2. Overview

2.1. Components

2.1.1. Gameboard

Gameboard contains a map that is composed of hexagons of different colors. Colors denote the terrain type or rivers. Power actions are demonstrated below the map. On the bottom left of the game board scoring tiles reside. On the top left of the gameboard cult bonuses and scoring rules are depicted. Moreover, victory point progress is placed as a frame surrounding the game board.

2.1.2. Cult Board

Cult board contains 4 tracks for the cult of fire, water, earth and air. Each track has 10 spaces players can advance with different rewards. On the bottom of the tracks, there are places for priests.

2.1.3. Faction Boards

There are 7 two-sided boards for 14 factions of the game.

2.1.3.1. Transformation Cycle

In the transformation cycle each terrain type is demonstrated separated by one spade symbol. The smaller number spades from one terrain type to the other is the cost of the transformation.

2.1.3.2. Supply

Each player starts the game with the following supply materials of their color.

- 8 Dwellings
- 4 Trading houses
- 1 Stronghold
- 3 Temples
- 1 Sanctuary
- 7 Priests
- 7 Markers
- 3 Bridges

2.1.3.3. Depicted Starting Resources

Depicted resources are on the top right corner of the fraction board. Number of workers, coins and cult advancement together with the cult type are depicted.

2.1.3.4. Bowls of Power

Bowls of power section reside on the top left corner of the faction. Power tokens are placed on top of these bowls.

2.1.4. Terrains and Structures

Structures are mentioned in 2.1.3.2. Terrains are to cover the terraformed terrains with the new terrain type.

2.1.5. Power Tokens, Coins, Workers and Priests

Power tokens only have one color, purple. Coins are distributed as 1, 2, and 5 coins. Workers are white cubes. Priests are mentioned in 2.1.3.2.

2.1.6. Scoring Tiles

Beginning of the game, six of the scoring tiles are chosen and placed on the gameboard. One of them is covered with the end of the game token. In each round, the scoring tile of the round provides players with extra rewards or ease for an action in action phase. Moreover, scoring tiles depict the end of round rewards which are based on the cult progress.

2.1.7. Favor Tiles

Favor tiles are laid out as 3x4 matrix by their types of rewards they yield. For each cult track, there is a unique favor tile that provides 3 points to be used on it. The other 8 favor

tiles provide 1 or 2 points to be used on a specific cult track together with additional actions or rewards for the player. There exist 3 favor tile of each of the 8 types.

2.1.8. Bonus Cards

There are 9 bonus cards in the game. Each bonus card has a reward on their face. Rewards on the bonus cards are additional income in the first phase of each round.

2.1.9. Town Tiles

There are 5 types of town tiles in the game and each type has 2 tiles. Each town tile has a reward on their face for the player to gain after they have founded a town. Rewards are Victory Points, Power, advancement on cult tracks or resources.

2.2. Game setup

2.2.1. Setup of the Faction Boards

Setup of Terra Mystica begins with assignment of factions. 2 to 5 faction boards are distributed to the players. Each player chooses one side of the faction board. After the distribution of the faction boards, each player places their supply(priests, bridges and structures) on the faction board. Then, each player collects their starting resources and makes the cult advancements. Moreover, each player places their power tokens onto the power balls on their faction boards.

2.2.2. Setup of the Gameboard

6 randomly selected scoring tiles are placed on the gameboard and one that corresponds to the 6th round is covered with the game end token. Favor tiles are placed near the gameboard in a 3x4 matrix. Cult board is also placed near the gameboard. Then bonus cards are randomly selected. The number of bonus cards is 3 more than the number of players. One action token is put on each power action that is on the bottom of the gameboard. Town tiles, workers and coins reside next to the game board.

2.2.3. Setup of the First Structures

After the starting player is set each player places one Dwelling on their home terrains in clockwise order, then starting from the last player, this action is repeated in reverse order.

2.2.4. Choosing of Bonus Cards

Beginning with the last player, each player chooses one bonus card in counter clockwise order. Consequently, 3 bonus cards remain unpicked on each of which one coin is placed.

2.3. Gameplay

Terra Mystica consists of 6 rounds and each of which has 3 phases.

2.3.1. Phase 1: Income

2.3.1.1. Income for Structures

Each player takes workers equal to the number of visible Worker symbols on the Dwelling track of their faction board; coins equal to the number of visible Coin symbols on the Trading House track of their faction board; priests equal to the number of visible Priest symbols on the Temple track and Sanctuary spot of their faction board and power equal to the number of visible Power symbols on the Trading House track and (not always) on the Sanctuary spot of their faction board.

2.3.1.2. Income for Cards and Tiles

Each player gets the income depicted on the bonus cards and favor tiles they possess in the beginning of each round.

2.3.1.3. Gaining Power

Each player is given 12 power tokens in the setup phase and there is no way to increase the number of tokens one player has. Gaining power; therefore, does not mean gaining power tokens. Gaining power enables players to move their tokens from the first bowl to the second one or from the second one to the third one.

Even though gaining power is explained under the section of Income Phase, it can happen in the other stages too.

2.3.2. Phase 2: Actions

There are 8 different actions players can take once per turn. In addition there are 2 more actions.

2.3.2.1. Transform and Build

2.3.2.1.1. Transform

To transform a terrain, each faction has different requirements depicted in the transformation cycle of the faction board. Players are allowed to transform terrains into any terrain provided that the terrain they wish to transform is unoccupied and adjacent to their structures.

2.3.2.1.2. Build

Players can build a dwelling on a terrain if and only if the terrain is of their color(home terrain of their faction), unoccupied and adjacent to their structures. Dwellings normally cost 1 worker and 2 coins.

2.3.2.2. Advancing on the Shipping Track

Players may choose to expand beyond River spaces, resulting in indirect adjacency. This is allowed to a extent that is indicated in the shipping track of faction boards. So as to be able to expand to a further extent, a player has to pay 1 Priest and 4 Coins. Each advancing on the shipping track is rewarded with victory points.

2.3.2.3. Lowering the Exchange Rate for Spades

Spades cost 3 workers by default. Players can reduce this rate by paying 2 workers, 5 coins and 1 priest. This rate is indicated in the exchange track of the faction boards. This action is rewarded with 6 victory points.

2.3.2.4. Upgrading a Structure

There are four possible upgrades and two of which can only be done once.

2.3.2.4.1. From Dwelling to Trading House

This upgrade costs 2 workers and 6 coins unless there are structures of other players directly adjacent to the dwelling. In that case, the cost is 2 workers and 6 coins.

2.3.2.4.2. From Trading House to Stronghold

The cost of this upgrade varies between factions. This upgrade unveils a special ability of the faction.

2.3.2.4.3. From Trading House to Temple

This upgrade costs 2 workers and 5 coins and is rewarded with one favor tile.

2.3.2.4.4. From Temple to Sanctuary

The cost of this upgrade varies between factions and is rewarded with one favor tile.

2.3.2.4.5. Gaining Power via Structures

Players do not gain power for their own structures. However, players gain power when one of their opponents build or upgrade a structure that is directly adjacent to them. Amount of gained power for each structure is depicted in the structure track on the faction board. Players can gain as many power as the total number of power corresponding to the structures that are directly adjacent to the newly built or upgraded structure. Gaining

power in this way is up to the player as it requires them to lose victory points equal to one fewer than the total number of power gained.

2.3.2.5. Send a Priest to the Order of a Cult

Players can place a priest to the spaces on the bottom of the cult track. This results in 2 or 3 space advancements on the corresponding track. This action may also result in gaining power as each cult track has power income in their 3rd,5th,7th and 10th spaces providing the player that passes by with 1,2,2, and 3 power(s) respectively.

2.3.2.6. Power Actions

Power actions are indicated by orange octagons and cost players power. Those that are on the bottom of the gameboard can only be taken once per round. Upon having been taken, a power action is blocked for the rest of the round and is covered by an action token.

2.3.2.7. Special Actions

Special actions are also indicated by orange octagons and can only be taken once per round. Special actions can be gained via Strongholds(for some factions), favor tiles and bonus cards. Upon having been taken, a special action is blocked for the rest of the round and is covered by an action token.

2.3.2.8. Pass

Players may choose to stop taking actions or may no longer be able to take actions for the rest of the round. If this is so, they can pass. The first player to pass becomes the starting player of the next round by taking the starting player token. Upon passing, a player should return their bonus card and take a new one.

2.3.2.9. Power Bowl Conversions

Anytime during their turn, a player can do as many of the following conversions as they want. These conversions are indicated below the 3rd power bowl on the faction board.

- Spend 5 power for 1 priest
- Spend 3 power for 1 worker
- Spend 1 power for 1 coin
- Convert a priest to a worker
- Convert a worker to a coin

If a player does not have enough power in the 3rd power bowl for the action or the conversion they wish to take, they can move power tokens from the 2nd bowl to the 3rd bowl by sacrificing half of the tokens. Sacrificed tokens are removed from the game till the game ends.

2.3.2.10. Founding a Town

Players can found one or more towns throughout the game. In order for a town to be founded, there should be at least 4 structures that are directly adjacent to each other unless one of them is a sanctuary. If one of the structures is a sanctuary then having 3 structures suffices. In addition to the direct adjacency condition, the structures should have more power value than 7 in total. Upon building a town, a player gets a town tile and places it under one of the structures of which the town consists.

2.3.3. Phase 3: Cult Bonuses and Clean-up

After each player passes for the round, the action phase ends and the clean-up phase begins.

2.3.3.1. Cult Bonuses

Cult bonuses that are depicted on the scoring tile of the current round is rewarded for the players whose progress matches the condition. Multiple rewards can be given to one player.

2.3.3.2. Return of Action Tokens

Any action token that resides on one of the power actions on the gameboard, special actions on the faction boards, favor tiles, and bonus cards are removed.

2.3.3.3. Coins on Bonus Cards

1 coin is put on the unpicked bonus cards. There can be multiple coins on a bonus card if a card remains unpicked for multiple rounds.

2.3.3.4. Turn the Scoring Tile Face Down

The scoring tile corresponding to the current round is turned face down in the cleanup phase of the round.

2.4. End of the Game and Final Scoring

After each player passes in the action phase of the 6th round, the game ends.

2.4.1. Cult Scoring

No cult bonuses are given in the 6th round hence the game end token covers the scoring tile of the round. Score of each cult track is evaluated separately in the following manner.

- The highest player on the track gets 8 victory points.
- The second highest player on the track gets 4 victory points.
- The third highest player on the track gets 2 victory points.

Even if they meet one of the conditions above, no victory points is given from the cult track to a player if they are on the 0th space of the track.

In case of a tie, victory points are divided(rounded down if necessary) and shared.

2.4.2. Area Scoring

Structures that are directly or indirectly adjacent to each other are considered as connected. The number of connected structures may result in victory points in the following manner.

- The player with the highest number of connected structures gets 18 victory points.
- The player with the highest number of connected structures gets 12 victory points.
- The player with the highest number of connected structures gets 6 victory points.

In case of a tie, victory points are divided(rounded down if necessary) and shared.

2.4.3. Resource Scoring

Players get 1 victory point for every 3 coins they possess.

2.4.4. The Winner(s)

The player with the highest number of victory points wins the game. In case of a tie, there is more than one winner.

2.5. Factions

The game has fourteen different factions. Factions are categorized by their home terrains. The game cannot contain two factions of the same home terrain. Factions change the game mechanics greatly by introducing unique abilities to the players. Faction abilities are divided into two as general ability and Stronghold ability. General abilities are active from beginning to end of the game whereas Stronghold abilities are activated when a Stronghold is built.

2.5.1. Forest Factions

2.5.1.1. Auren

2.5.1.1.1. General Ability of Auren

Auren faction does not have a general ability.

2.5.1.1.2. Stronghold Ability of Auren

Right after building a Stronghold, the player gets a favor tile of their choice for once. Upon building a Stronghold, the player can advance two places on a chosen Cult track. This action constitutes a special action (See 2.3.2.7.).

2.5.1.2. Witches

2.5.1.2.1. General Ability of Witches

The player gets 5 Victory Points when they founded a town.

2.5.1.2.2. Stronghold Ability of Witches

The player may build a dwelling on an unoccupied Forest space, regardless of adjacency, without any cost. This action is considered as a special action (See 2.3.2.7.). This special action cannot follow a transformation action (See 2.3.2.1.).

2.5.2. Lakes Factions

2.5.2.1. Mermaids

2.5.2.1.1. General Ability of Mermaids

The player may go over 1 river space when founding a town. If built this way, the tile of the town is placed on the river space.

2.5.2.1.2. Stronghold Ability of Mermaids

Right after building a Stronghold, the player advances one space on the shipping track without any cost. This can be done for once. Rewards of this advancement remain the same and are given to the player.

2.5.2.2. Swarmlings

2.5.2.2.1. General Ability of Swarmlings

The player get 3 workers when founding a town.

2.5.2.2.2. Stronghold Ability of Swarmlings

The player may upgrade a Dwelling to a Trading House without any cost. This action constitutes a special action (See 2.3.2.7.).

2.5.3. Swamp Factions

2.5.3.1. Alchemists

2.5.3.1.1. General Ability of Alchemists

The player can trade 1 Victory Point for 1 Coin or 2 Coins for 1 Victory Point anytime without any limitation.

2.5.3.1.2. Stronghold Ability of Alchemists

Right after building a Stronghold, the player gains 12 power. Moreover, after building a Stronghold, the player gains 2 Power whenever they get a Spade.

2.5.3.2. Darklings

2.5.3.2.1. General Ability of Darklings

The player needs to pay their transformation with the same number of priests instead of workers. Each transformation rewarded by 2 Victory Points.

2.5.3.2.2. Stronghold Ability of Darklings

Right after building a Stronghold, the player can trade 1 Worker for 1 Priest. In the same turn Stronghold is built, this trade can occur at most 3 times. After the turn terminates this trade can never occur again.

2.5.4. Wasteland Factions

2.5.4.1. Chaos Magicians

2.5.4.1.1. General Ability of Chaos Magicians

The player start the game with 1 Dwelling. The player gets 2 Favor Tiles when building a Temple or a Sanctuary.

2.5.4.1.2. Stronghold Ability of Chaos Magicians

The player can take 2 actions consecutively. This is called “double turn” and constitutes a special action (See 2.3.2.7.).

2.5.4.2. Giants

2.5.4.2.1. General Ability of Giants

The player pays 2 Spades for transforming terrain.

2.5.4.2.2. Stronghold Ability of Giants

The player gets 2 Spades for free whenever they are to transform a terrain that is adjacent to their home terrains. This action constitutes a special action (See 2.3.2.7.). This special action can be followed up with building a Dwelling on the newly transformed terrain. The cost of building a Dwelling is applied.

2.5.5. Plains Factions

2.5.5.1. Halflings

2.5.5.1.1. General Ability of Halflings

The player gains 1 Victory Point each time they get a Spade.

2.5.5.1.2. Stronghold Ability of Halflings

Right after building a Stronghold, the player gets 3 Spades. A transform and build action (see 2.3.2.1.) can follow this in the same turn.

2.5.5.2. Cultists

2.5.5.2.1. General Ability of Cultists

If one or more opponents gain Power via Structures (see 2.3.2.4.5.) by adjacency to one the player's structures, the player advances 1 space on a chosen cult track. This is not stackable, i.e., regardless of the number of opponents gaining power the player can advance only 1 space.

2.5.5.2.2. Stronghold Ability of Cultists

Right after building a Stronghold the player gains 7 Victory Points.

2.5.6. Desert Factions

2.5.6.1. Fakirs

2.5.6.1.1. General Ability of Fakirs

When taking transform and build action (See 2.3.2.1.), the player can skip one space by paying 1 Priest extra. This is called carpet flight. Carpet flight results in 4 Victory Points for the player. Moreover, in the final scoring, carpet flight is taken into account for connection of the structures.

2.5.6.1.2. Stronghold Ability of Fakirs

Upon building a Stronghold, carpet flight allows the player to skip 2 spaces. Moreover, the effect of carpet flight on connection in the final scoring will be taken into account accordingly.

2.5.6.2. Nomads

2.5.6.2.1. General Ability of Nomads

The player starts the game with 3 Dwellings.

2.5.6.2.2. Stronghold Ability of Nomads

The player can transform a terrain into their home terrain(Desert) without any cost. This action constitute a special action (See 2.3.2.7.). This transformation can be followed up with a building a Dwelling on the newly transformed terrain.

2.5.7. Mountains Factions

2.5.7.1. Engineers

2.5.7.1.1. General Ability of Engineers

The player may build a bridge for 2 workers as an action. This action can be taken multiple times per round.

2.5.7.1.2. Stronghold Ability of Engineers

The player gets 3 Victory Points for each bridge that is connecting two of their structures.

2.5.7.2. Dwarves

2.5.7.2.1. General Ability of Dwarves

When taking transform and build action (See 2.3.2.1), the player may skip one space by paying 2 Workers extra. This is called tunneling. Each tunneling is rewarded by 4 Victory Points. In the final scoring, tunnelling is taken into account for connection of the structures.

2.5.7.2.2. Stronghold Ability of Dwarves

Tunneling costs only 1 workers extra instead of 2.

2.6. Rules

1. Player can take actions only in their own turn.
2. In his/her turn, a player can take only one action.
3. All actions, except for passing, can be taken several times per round.
4. Power cannot be moved from the second bowl to the third if the first bowl is empty.
5. Provided that all power tokens are in the third bowl, players cannot gain more power.
6. Power can only be spent from the third power bowl.
7. Transformations are priced with spades. The rates are depicted in the transformation cycle of each faction board.
8. Spades cannot be saved and thus must be used immediately.
9. In one turn, a player can transform several terrains and put one and only one dwelling on one of them.
10. Transformations do not have to be followed by building dwellings.

11. From any terrain to any terrain, transformation is possible.
12. Terrains having structures on them cannot be transformed.
13. In building and upgrading, structures are removed from the faction board from left to right.
14. Terrains and structures can be adjacent to each other either directly or indirectly.
15. Two terrains or structures are directly adjacent to each other if they share a hexagon edge or are connected with a bridge.
16. Two terrains or structures are indirectly adjacent to each other if they are separated by a number of river spaces not exceeding the player's shipping level.
17. A player cannot take a favor tile which s/he already possesses.
18. A favor tile can be used immediately after it is earned.
19. Affected parties decide in clockwise order when a situation results in gaining power via structures (see 2.3.2.4.5.). Decision making starts with the player that precedes the active player in play order.
20. Players cannot have negative victory points.
21. Each cult track can house only one player in their 10th space.
22. Once a priest is sent to a cult track, it cannot be returned.
23. Power bowl conversions are not considered as turn actions; therefore, can be taken multiple times in a single turn.
24. All resources can be kept for the next round.
25. Cult bonuses are distributed in the play order of the next round.
26. Players cannot build dwellings in the cleanup phase.
27. When a Nomad is present in a game, the setup of the first structures ends when Nomad places their third Dwelling.
28. Chaos Magicians do not put their Dwelling in the sitting order. They place their Dwelling at last.
29. When both a Nomad and a Chaos Magician are present in a game, the setup of the first structures ends when the Chaos Magician places the dwelling after the placement of the third Dwelling of the Nomad.

3. Functional requirements

3.1. Multiplayer game

Players must be able to play Terra Mystica with each other on a server. Each player has to choose a color to represent himself. Players must be able to perform all the activities listed above in the gameplay section and the server should be able to handle these interactions.

3.2. Help

Players must be equipped with help pages containing all the information about the game. Help pages should be properly categorized and easy to be navigated through.

3.3. Choose a faction

Each player must choose a faction before starting the game. Factions should be represented informatively to ease this process.

3.4. Building Dwellings

Players must be able to build dwellings if the game is on the action phase of a round and the necessary conditions are met. Dwellings must be demonstrated on the map clearly indicating its owner.

3.5. Transforming Terrains

Players must be able to transform terrains if the game is on the action phase of a round and the necessary conditions are met. After transformation, terrains should demonstrate not only the new terrain but also the old terrain slightly.

3.6. Improvements in Faction Abilities

Players must be able to improve shipping skills and terraforming skill whenever the conditions for either of them is met in the action phase of a round.

3.7. Use of Priests

Players must be able to use the priests in their supplies for the actions that require. The owner, removal and displacement of the priests should be demonstrated clearly.

3.8. Power Actions

Players must be able to take power actions if the necessary conditions are met. Conditions and the after effects of power actions must be informatively documented and clearly demonstrated.

3.9. Special Actions

Players must be able to take power actions if the necessary conditions are met. Conditions and the after effects of special actions must be informatively documented and clearly demonstrated.

3.10. Upgrading Structures

Players must be able to upgrade structures if the necessary conditions are met. All structures should be distinctively demonstrated on the gameboard.

3.11. Power Bowl Conversions

Players must be able to manipulate the power bowls on their faction boards. The game should demonstrate the content of each bowl. All the conversions should be informatively documented and clearly demonstrated.

4. Nonfunctional requirements

4.1. Documentation

Terra Mystica game should provide its players with instructive documentations about the game. Consequently, introduction of new players to the game will be easier. For its developers, design and implementation process should be recorded and documented. All methods, classes and algorithms used should be explained in the documents and in the code segments. Also, changes between versions should be recorded for further bug detections and fixes.

4.2. Extensibility

Even though the game is highly complex, it is still open for development. So the design and the implementation should pave the way for future development. To do so, an object oriented design in which all classes have single responsibility will be followed. Consequently, the game can be improved without requiring vast changes in its structure.

4.3. Efficiency

The graphical user interface must be responsive to the user inputs with 1 ms on MacOS, Windows and Linux platforms that are equipped with required hardware for Java [2]. For this, brute-force solutions are to be averted. Because of this, there can be a trade off in memory as increase in time efficiency may result in decrease in memory usage.

4.4. Usability

The game must avoid ambiguity and be informative not only in explanation of the game but also in the active game. The game must have clear images to represent all the components of the game. If an action is prohibited at an instant of the game, the player should be notified and be informed about the reasons. It will be formatively analyzed that no actions will take more than 3 user interactions to be completed [3].

5. System models

5.1. Use case model

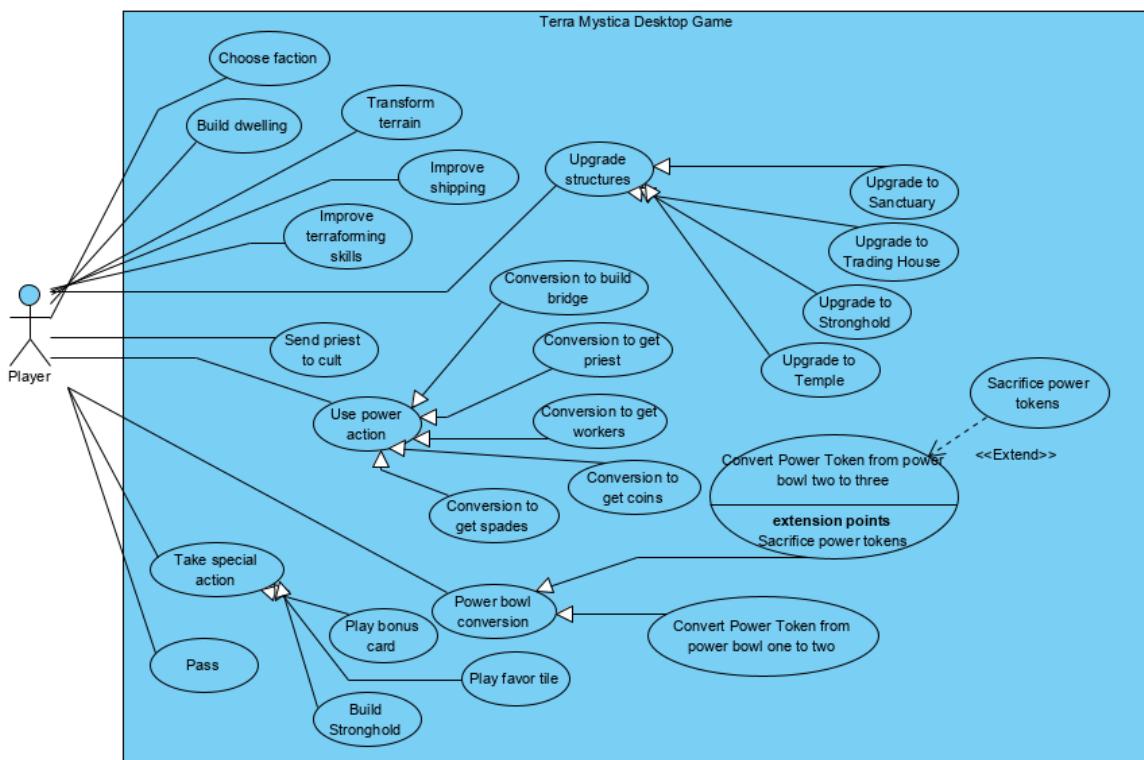


Figure 1: Use Case Diagram

5.1.1. Use Case Descriptions

5.1.1.1. Name: Choose faction

- Participating Actor: Player
- Entry Condition:

- Beginning of the game.
- Current player has not selected a faction yet.
- Exit Condition
 - Every player in the game choose a faction.
- Flow of Events
 1. Current player chooses a faction from available factions.
 2. The faction board assigned to the player.
- Special Requirements: *None*

5.1.1.2. Name: Transform terrain

- Participating Actor: Player
- Entry Condition:
 - Current player must have enough spade resources for the terrain type.
 - No structures on the terrain space.
 - Terrain space needs to be directly or indirectly adjacent to one of current player's Structures.
- Exit Condition:
 - Player puts marker of home terrain on the terrain space.
- Flow of Events:
 1. Current player chooses an unoccupied terrain.
 2. Current player use the spades in accordance with the terrain type.
 3. Current player marks the selected terrain space with the home terrain marker.
- Special Requirements: *None*

5.1.1.3. Name: Build dwelling

- Participating Actor: Player
- Entry Condition:
 - The terrain matches player's home terrain.
 - The terrain is unoccupied.
 - Directly or indirectly adjacent to one of the player's structures.
 - When player is at the first round player can ignore direct and indirect adjacency rule when building a dwelling.
- Exit Condition:
 - Player builds the dwelling.
- Flow of Events:
 1. Current player selects a terrain which matches player's home terrain.
 2. Current player has to choose an unoccupied terrain space.
 3. At the first round player can build dwelling without considering direct-indirect adjacency rule.

- 4. Current player chooses a terrain space which directly or indirectly adjacent to it's structures.
- 5. Current player pays resources to build the dwelling.
- 6. Current player places the dwelling onto the selected terrain space.
- Special Requirements: *None*

5.1.1.4. Name: Improve Shipping

- Participating Actor: Player
- Entry Condition:
 - Current player is at the 'Action Phase' of the round.
 - Current player has enough resources to improve it's 'Shipping'.
- Exit Condition:
 - Current player advances the marker on the Shipping track.
- Flow of Events:
 1. Current player choose action 'improve Shipping' at the action phase of the round.
 2. Current player pays the cost of the action indicated as 1 Priest and 4 Coins.
 3. Current player advances the marker on the Shipping track.
- Special Requirements: *None*

5.1.1.5. Name: Improve terraforming skills

- Participating Actor: Player
- Entry Condition:
 - Current player has enough resources to lower the exchange rate of spades.
 - Current player must be at the 'Action Phase'.
- Exit Condition:
 - Update the exchange rate of spades.
- Flow of Events:
 - Player use 2 workers 5 coins and 1 priest.
 - Lowers the exchange rate of spades as an action.
- Special Requirements: *None*

5.1.1.6. Name: Upgrade Structures

- Participating Actor: Player
- Entry Condition:
 - Current player must have enough resources to upgrade the structure.
- Exit Condition
 - Current player places the new structure on the game board.
- Flow of Events:
 1. Replace the current structure with the structure to upgrade.

2. Return the old structure.
 3. Update faction board.
- Special Requirements: *None*

5.1.1.7. Name: Send priest to cult

- Participating Actor: Player
- Entry Condition:
 - Current player has enough priests in supply.
- Exit Condition:
 - Current player moves the marker on the cult track as much spaces based on the priest's location on the cult track.
- Flow of Events:
 1. Current player chooses one of the cult tracks.
 2. Current player chooses one of the 4 places on the cult track to send the priest.
 3. Current player advances on the cult track based on the value indicated on the marker priest placed on.
 4. If priest pass power symbols convert that many power tokens.
- Special Requirements: *None*

5.1.1.8. Name: Use power action

- Participating Actor: Player
- Entry Condition:
 - Power action should be available.
 - Current player must have enough power resources to take power action.
 - They can be taken once per round.
- Exit Condition:
 - All power tokens required to take power action moved from bowl 3 to bowl 1.
- Flow of Events:
 1. Current player moves power tokens required to take power action moved from bowl 3 to bowl 1.
 2. According to the purpose, available power tokens and availability of power action it is chosen. Conversion can be taken in order to obtain bridge, priest, workers, coin or spades. Obtained spades and bridges are available for only that turn others can be stored.
 3. Action token put on its spade on the Game Board.
 4. The power action becomes unavailable to use until next round.
- Special Requirements: *None*

5.1.1.9. Name: Power bowl conversion

- Participating Actor: Player
- Entry Condition:
 - Power bowl 1 or bowl 2 is not empty.
- Exit Condition:
 - Player converts the Power Tokens in between the power bowls
- Flow of Events:
 1. Current player gains power as income or by advancing the cult tracks.
 2. Gained power corresponds to power tokens.
 3. Current player converts power tokens depending on the number of power tokens in the power bowls.
- Special Requirements: *None*

5.1.1.10. Name: Convert Power Token from power bowl 2 to 3

- Participating Actor: Player
- Entry Condition:
 - Power bowl 1 is empty.
 - There are Power Tokens in power bowl 2.
- Exit Condition:
 - Current player moves the Power Tokens according to the power gained.
- Flow of Events:
 1. Current player gains power as income or by advancing the cult tracks.
 2. Gained power corresponds to power tokens.
 3. Current player converts power tokens from power bowl 2 to 3.
- Special Requirements: *None*

5.1.1.11. Name: Sacrifice power tokens

- Participating Actor: Player
- Entry Condition:
 - Current player has power tokens in the power bowl 2.
 - Current player has not enough power to take action.
- Exit Condition:
 - Current player sacrifices power tokens from bowl 2 to bowl 3.
- Flow of Events:
 1. Current player decides the number of power tokens to sacrifice.
 2. Current player converts power tokens from bowl 2 to bowl 3.
 3. Current player takes out as many power tokens as many as it converts from power bowl 2 to bowl 3.
- Special Requirements: *None*

5.1.1.12. Name: Convert Power Token from power bowl 1 to 2

- Participating Actor: Player
- Entry Condition:
 - Power bowl 1 is not empty.
- Exit Condition:
 - Player moves the Power Tokens according to the power gained.
- Flow of Events:
 1. Player gains power as income or by advancing the cult tracks.
 2. Gained power corresponds to power tokens.
 3. Player converts power tokens from power bowl 2 to 3.
- Special Requirements: *None*

5.1.1.13. Name: Take special action

- Participating Actor: Player
- Entry Condition:
 - Current player is at the 'Action Phase' of the round.
 - Player must have one of the favor tiles or bonus cards with an orange hex or a stronghold with orange hex symbol.
- Exit Condition:
 - Player's special action becomes unavailable until the next round.
- Flow of Events:
 1. Current player choose to take special action.
 2. The orange hex indicating special action becomes unavailable until the next round.
- Special Requirements: *None*

5.1.1.14. Name: Pass

- Participating Actor: Player
- Entry Condition:
 - Current player is at the Action Phase of the game.
- Exit Condition:
 - Current player takes the 'Pass' action.
- Flow of Events:
 1. Current player's turn in the Action Phase.
 2. Current player selects the 'Pass' action.
 3. Current player won't be able to participate action turns for the current round.
 4. Current player takes the starting player token for the next round.

5. Current player chooses a new bonus card from the remaining bonus cards.
 6. Current player returns the old bonus card.
- Special Requirements: *None*

5.2. Dynamic models

5.2.1. Sequence Diagrams

5.2.1.1. Sequence Diagram for Terraforming, Building Dwelling and upgrading a Structure

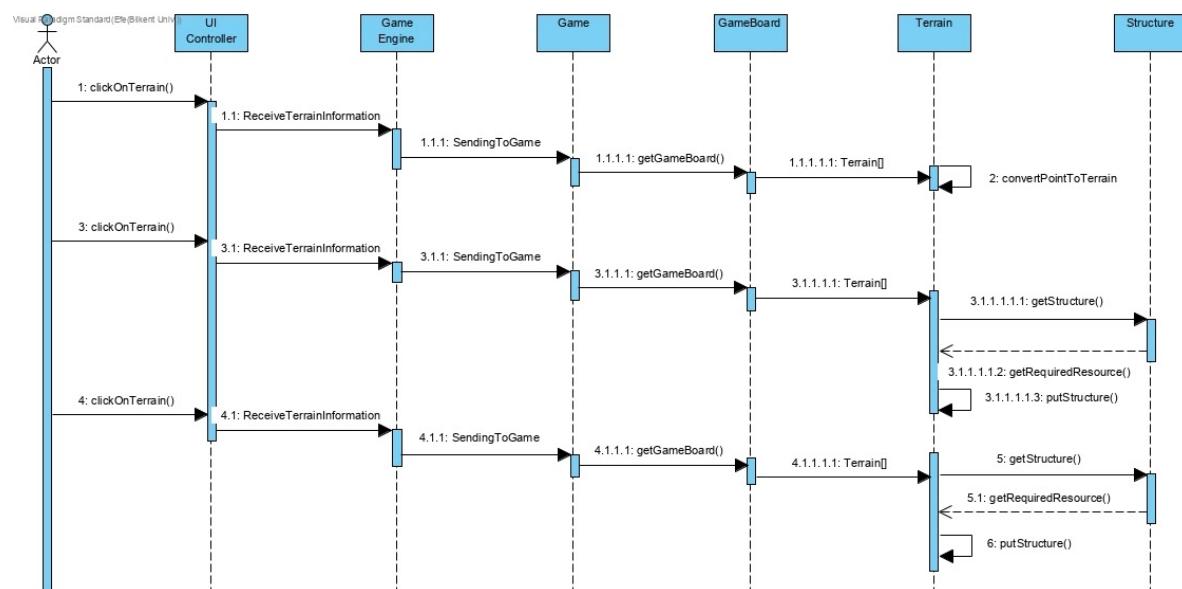


Figure 2: Sequence Diagram for Terraforming, Building Dwelling and Upgrading Structure

In this scenario, if a user wants to transform the terrain type the user clicks on an available terrain on the map. After clicking the terrain, the terrain information will be sented to the Game through Game Engine and the terrain transformation popup will appear on the screen. The player will select the type of dwelling and the user choice will be sent to the Game through Game Engine. Information will be taken as an input and change the selected terrain type. If a user wants to build a dwelling on an available terrain, after clicking on the dwelling type, the required resources will be calculated together with the resources the player has to check whether it satisfies the conditions. After validation, dwelling will display on the terrain. If a user wants to upgrade the structures, the same steps will be taken. However, this time users will be able select the structure to be upgraded. For example, the trading houses can be upgraded to a stronghold or temple.

5.2.1.2. Sequence Diagram for converting power tokens

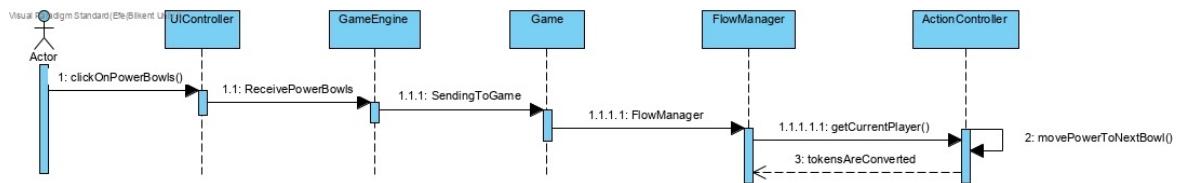


Figure 3: Sequence Diagram for converting power tokens

In this diagram, the user clicks on the power bowls to select the power which the power tokens will transfer. The Game takes the user information from the Game Engine and sends it to FlowManager. Afterwards, ActionController takes the command and the power tokens move to the next bowl. If the selected power satisfies power conversion rules the UI will update the power bowls. After that FlowManager takes the information back.

5.2.1.3 Sequence Diagram for improving shipping and improving terraforming

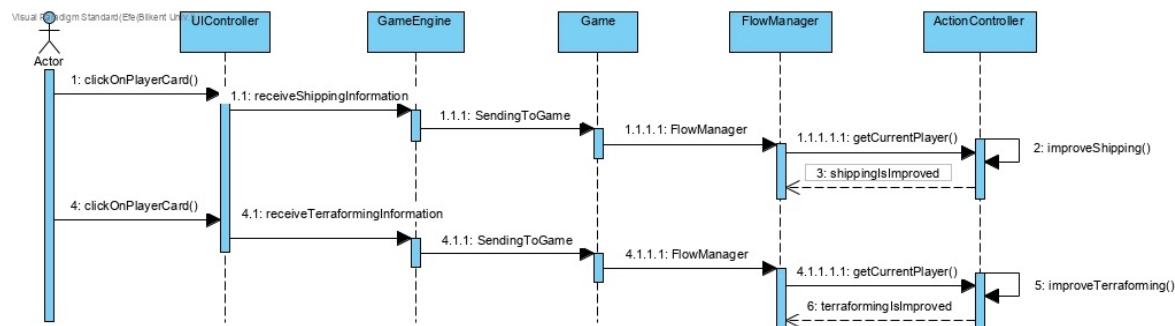


Figure 6: Sequence Diagram for improve shipping and improve terraforming

In these diagrams, the user clicks on the PlayerCard then the shipping information or terraforming information sends to the FlowManager via Game Engine and Game. Flow Manager takes the current player information and after that improve shipping or improve terraforming actions have been taken. These methods have interior resource check mechanisms, improveTerraforming checks spades and improveShipping checks priest and coins. After in both scenarios FlowManager takes the information back.

5.2.1.4 Sequence Diagram for advancing in cult board

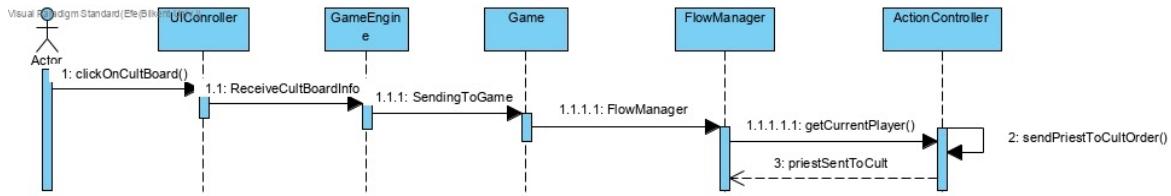


Figure 7: Sequence Diagram for Advancing in Cult Board

In this diagram, the user clicks on the cult track then cult track popup on the screen. The Game Engine takes the cult board information and sends the information to FlowManager via Game. FlowManager gets the current player information and sends it to the ActionController. Then the priest is sent to the cult board. After that FlowManager takes the information back.

5.2.2 State Diagrams

5.2.2.1 Upgrade Structures State Diagram

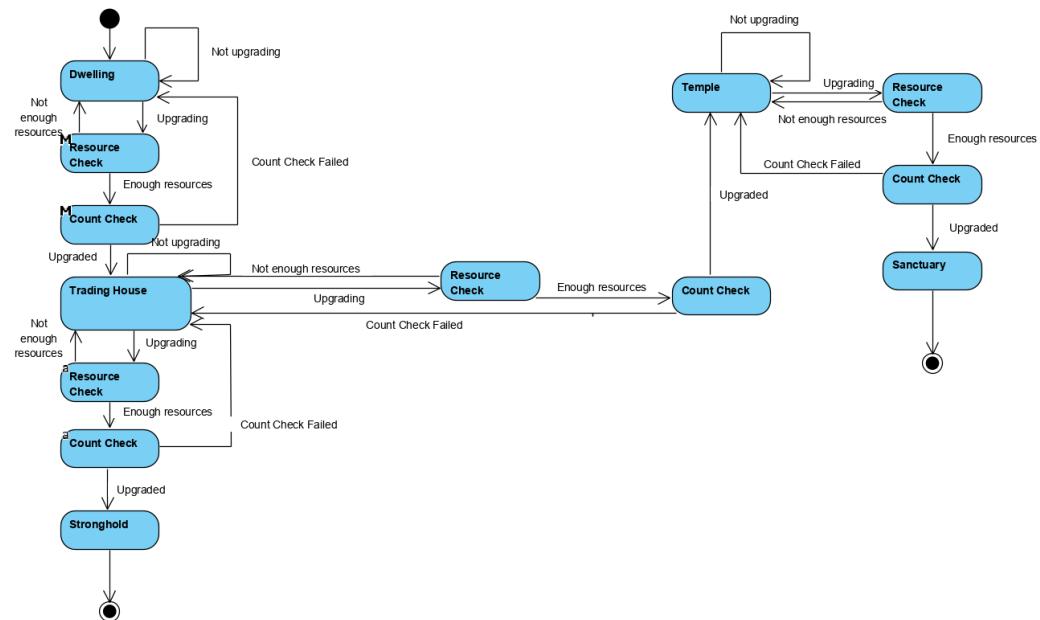


Figure 8: Upgrading Structures State Diagram

This state diagram shows the relevant states to upgrade a building in the game. There are two checkers which checks whether the structure can be upgraded to the next one. If there are enough resources and the player has enough structures the upgrade can be done. In addition to that there are two paths from trading post since trading posts can be

both upgraded to stronghold or temple, and the temple can be upgraded to the sanctuary. After upgrading these to sanctuary and stronghold. They can not be further upgraded since they are the highest possible buildings in their path.

5.2.3 Activity Diagrams

5.2.3.1 Calculating Victory Points

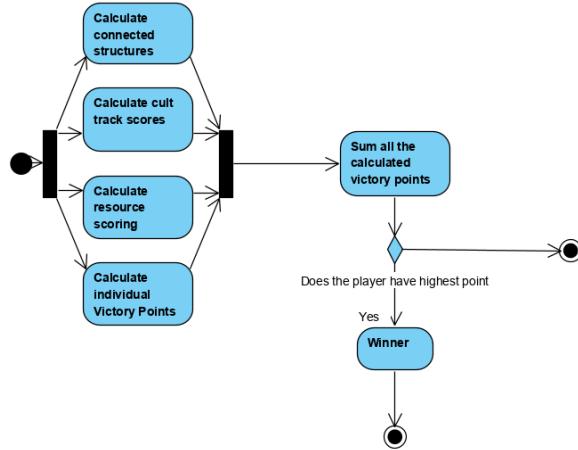


Figure 9: Activity Diagram for Victory Point Calculation

After the last rounds last phase to decide the winner of the game the victory points of each player is started to calculate. For each player the cult scoring is calculated by giving 8 points for the player highest on the track, 4 victory points for second and 2 victory points for third in the track. If there is a tie then the victory points are added then split for two players.

Then the number of connected structures are counted for each player to give them 18,12,6 respectively by their positions . Every player gets 1 Victory point per 3 coins that he/she has. And as last the individual Victory points are calculated from the bonus cards, scoring tiles, advancing on shipping track, and the special abilities that can convert less coins to victory points(Alchemists) and then all of them are added. If the player has the highest point he-she is the winner(If it is equal to another players victory points and they are the highest both of them are winners.In the game there can be more than one winner).

5.2.3.2 Gaining Power via Adjacency

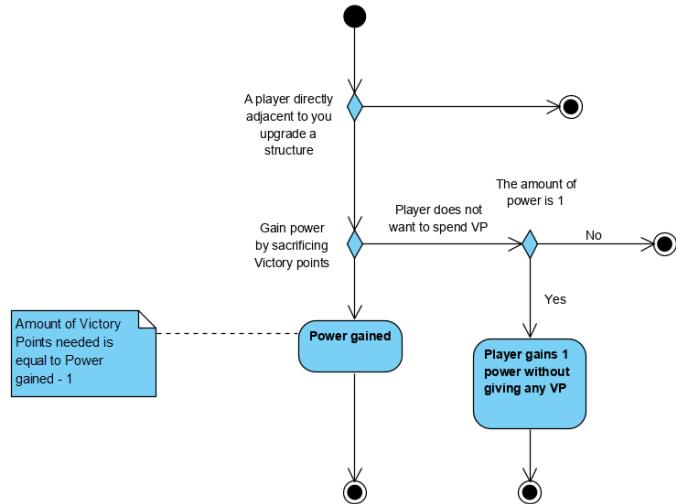


Figure 10: Activity Diagram for Gaining Power via Adjacency

In Terra Mystica, power is a fundamental resource that you want to hold. To gain power from structures, someone else has to build a structure adjacent to you, you can not gain any power from your own structures. So , if no one build a structure near (adjacent) to you, you can not gain power from structures. However, if someone builds a structure adjacent to your structures, you can gain power by sacrificing ($\text{gainedPower} - 1$) victory points. You have the right to not sacrifice your victory points but you will not get any powers if you do so. In addition to that, if the amount of the power that is going to be gained is 1 player can gain the power without sacrificing any of her/his victory points.

5.2.3.3 Founding Town

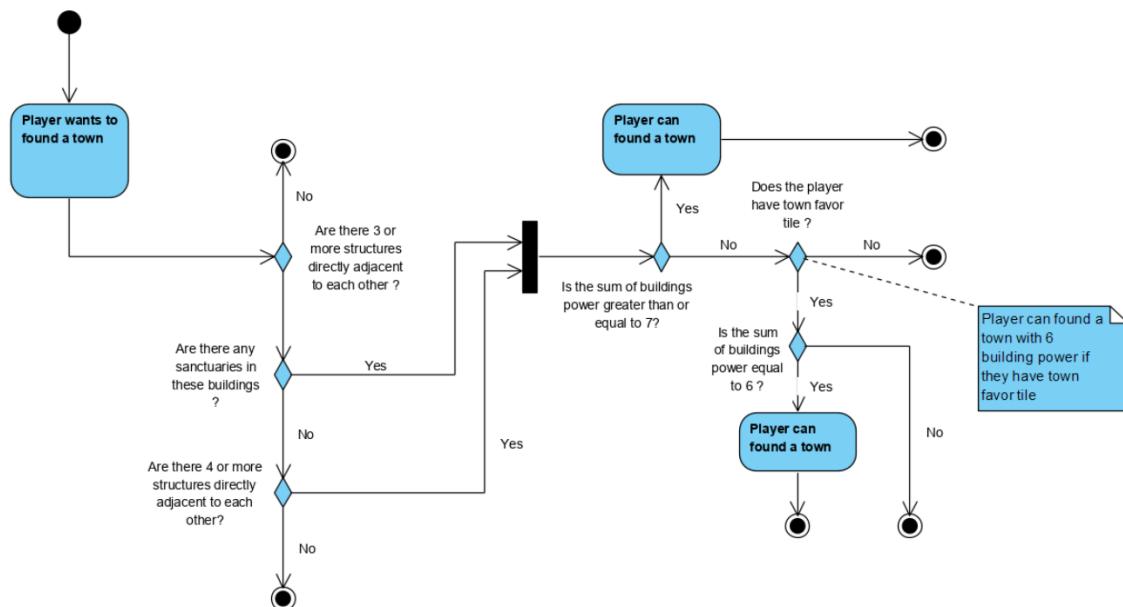


Figure 11: Activity Diagram of Building a Town

One of the actions that you can do in Action Phase is to found a town. However, there are some conditions to fill. There are two ways: One you have to have 4 or more structures directly adjacent to each other. Two, you can have 3 structures but one of them has to be sanctuary. After filling one of these conditions, then you have to have a power greater or equal to 7. There is also one more to found a town. If the player has both 6 building powers and the town favor tile the player can found a town. Otherwise you can not found a town.

5.3. Object and class model

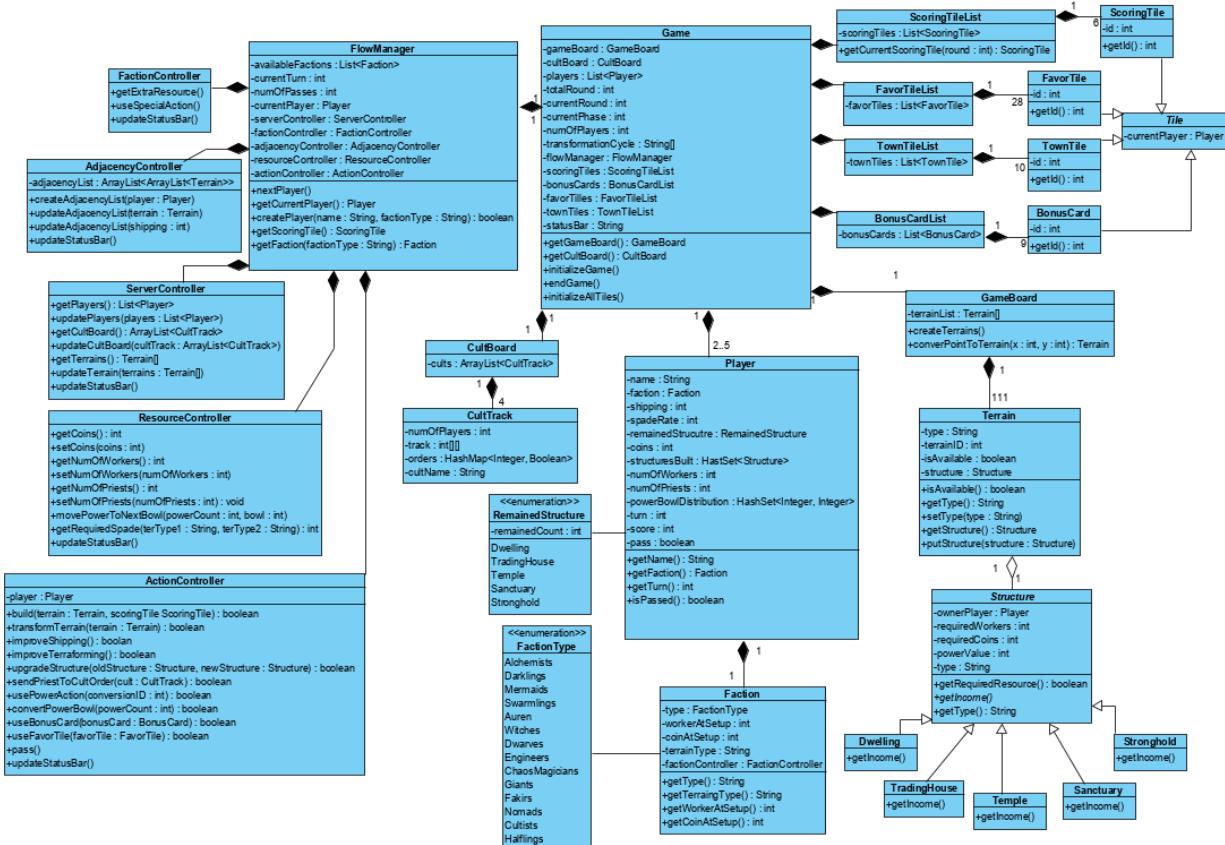


Figure 12: Object Model

- **Game:** Brings all entity objects together.
- **FlowManager:** Control the flow of the game, i.e., delegates checking if the conditions are met for an action and reports the aftereffect of an action.
- **FactionController:** Checks if the action is affected by the player's faction and/or affects any other player due to their faction.
- **AdjacencyController:** Checks if the action meets its adjacency criteria and manages the outcome of the action on adjacency.
- **ServerController:** Checks if the action requires an update on the database.
- **ResourceController:** Checks if the player has enough resources for the action. Also, manages the outcome of actions that result in resource distribution.
- **ActionController:** Manages the impact of the action on the flow of the game.
- **CultBoard:** Represents the cult board in the game which consists of 4 cult tracks.
- **CultTrack:** Represents the cult tracks.
- **Game Board:** Represents the terrain map of the game.
- **Player:** Contains player attributes.
- **Faction:** Contains faction attributes.
- **Gameboard:** Contains terrains.
- **Terrain:** Contains terrain attributes and a structure.
- **Structure(abstract):** Represents the attributes and function signatures of structure classes.
- **Dwelling, Trade Post, Temple, Sanctuary, Stronghold:** Represents the varying classes and their specifications.
- **FavorTileList:** Contains favor tiles that will be active in the game.
- **FavorTile:** Contains favor tile attributes.
- **ScoringTileList:** Contains scoring tiles that will be active in the game.
- **ScoringTile:** Contains scoring tile attributes.
- **TownTileList:** Contains town tiles.
- **TownTile:** Contains town tile attributes.
- **BonusCardList:** Contains bonus cards that will be active in the game.
- **BonusCard:** Contains bonus card attributes.
- **Tile(abstract):** Contains the shared attributes of all tiles.

5.4. User interface

5.4.1. Main Menu Mockup Screen

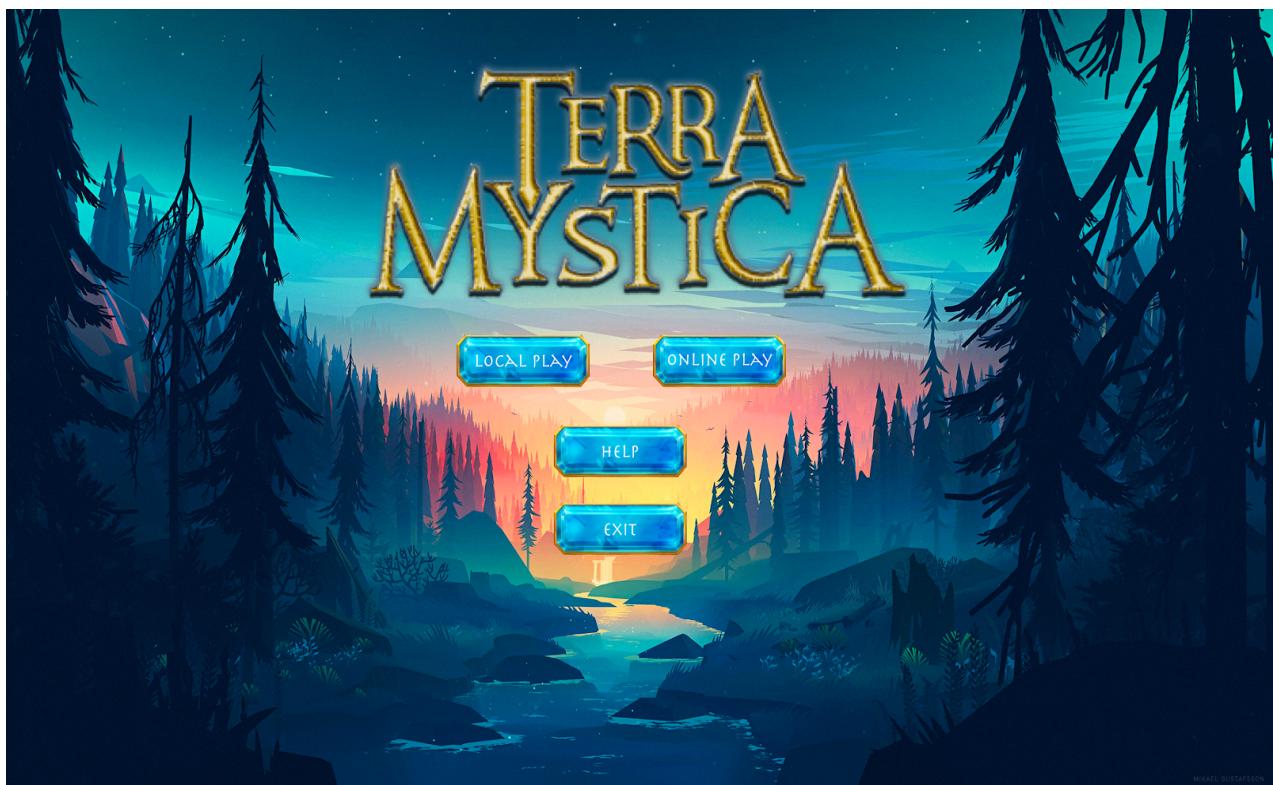


Figure 13: Main Menu Mockup

Terra Mystica's main menu will divided into 3 main sections: *Game Play*, *Help* and *Exit*. In the *Game Play* section user have 2 options to choose from which are *Play Online* and *Play Local*. By pressing the *Play Local* button user can play with other people around or with a bot. In *Online Play*, user will connect to a Wi-Fi network to match and play with other people. By pressing the *Help* button user can see the game rules. User will have an option to exit the game by pressing the *Exit* button.

5.4.2. Game Board Screen (4 Players)

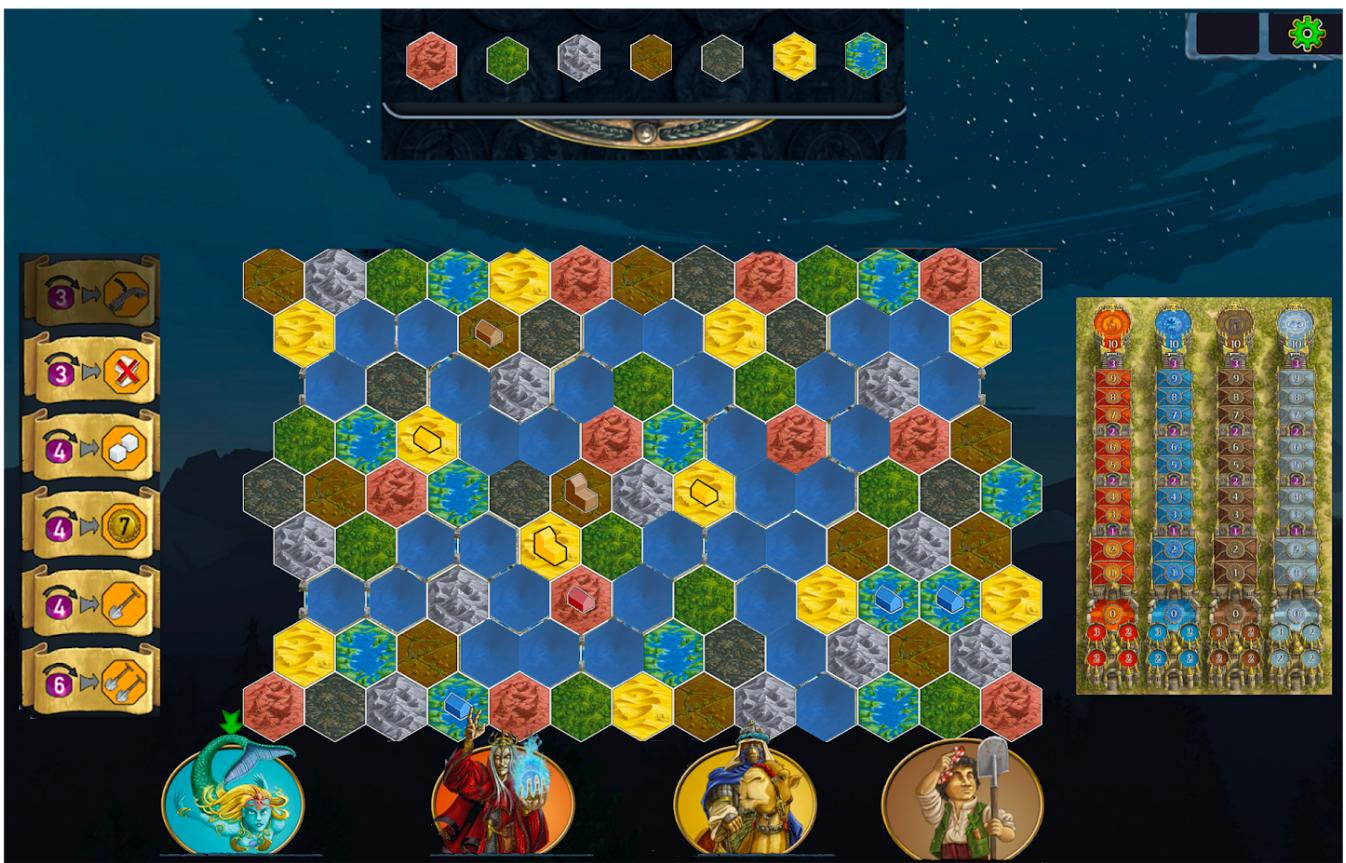


Figure 14: Gameboard Mockup

Game board displays the current state of the game. The player will be able to see other player's Faction board by clicking on top of the other player's Group symbol. The 6 cards at the left pane displays the possible Power Actions one take in each round. The right pane displays the state of the Cult Track. Player needs to select the terrain type from the upper pane in order to build structures on the map.

5.4.3. Player Faction Board



Figure 15: Faction Board Mockup

When a user clicks on a Faction board. They will be able to see the other player's Faction board state. The design of the faction board is open to change according to the requirements.

5.4.4. Choosing an action



Figure 16: Choose an Action Mockup

The possible action a player can take will appear as an pop-up. User will be able to choose an action by clicking on the action. If the resources of the player satisfies the action condition user will take the selected action.

6. Improvement Summary

1. The descriptions of game components are enhanced.
 - o Scoring tiles, favor tiles, bonus cards and town tiles are now analyzed better.
2. Analysis of factions is added.
3. New rules regarding factions are added.
4. Efficiency requirements are clarified in more detail.
5. Dynamic models are updated and improved.
 - o Return massages are introduced.
 - o Names are more coherent.
 - o So as to have them represent appropriate aspects of the system better, state and activity diagrams are updated or replaced.
 - o Faction specific features are introduced.

7. References

1. [Terra Mystica Manual](#)
2. [System Requirements for Java](#)
3. [Formative Usability Analysis](#)