

Refracture:

Final Design Document

By: Hazen Johnson, Eric Papke, DeWae Polk

COSC 3483: Game Development

Game Description and Story

In the game Refracture, the player must survive the harsh, earthquake-ridden continent called “Fool's Footing.” In this cruel landscape, the player must conquer the threats the earthquakes pose first and foremost, but the earthquakes are not the only problem. Landslides, volcanic eruptions, and the corrupt will of mankind add to the danger of Fool's Footing. The game includes some features of tower defense played in the light of real time strategy-like gameplay.

The player takes the role of a young man, who began life as a beggar and was exiled from his original home to Fool's Footing. Upon arriving at this new continent, he found shelter and guidance from a fellow exile who was soon granted leadership of the exiles, becoming known as “The Protector.” In the nation's attempt to “civilize” Fool's Footing, The Protector was given a newly developed material, called “SeisMantle”, to handle seismic waves to protect the settlement. He was successful in his efforts. That is, until a series of volcanic eruptions caused a devastating series of earthquakes. The Protector and his team went out to secure a part of SeisMantle defenses, but an earthquake struck the defenses, killing The Protector. The young man, matured by his travels and trials, gains leadership from his deceased mentor and now must lead his settlement in its efforts for survival and prosperity.

In Refracture, the player will defend his settlement using the expansive power of SeisMantle, while expanding outward to seize resources. Using research, the player can gain control over more powerful types of SeisMantle which have different effects on seismic waves. Research also plays a part in upgrading the city; in terms of more functional outposts, faster transports, and other various aspects. With the clever use of SeisMantle, and the power of advanced research, the player will find that he has a well-developed city with the power to hold strong against the perils of Fool's Footing and the strength to establish superiority over other settlements.

Features

The features of Refracture may be broken up into three basic categories: terrain features, player placeable features, and gameplay features. Terrain features are elements that will be placed on maps during generation and will generally be unaffected during gameplay. Player placeable features are the features which the player can manipulate directly. Gameplay features are those which are not directly controlled by the player but influence the player.

Terrain Features

Earthquake Origin

From these regions, earthquakes are generated during the game. Note that earthquake origins are regions and not singular points. As a result, the specific origin of each earthquake will be different, but all the earthquakes will originate from the region defined by the earthquake origin.

Water/Lakes

Bodies of water are added to the map for mainly one reason. This is that water prevents players from using space on the map. Lakes do not block earthquakes, but they do not permit a player to build defenses in the water. As a result, the player must build around the lake.

Mountains

Mountains are a central terrain feature which mostly appear as contiguous ranges. They form an effective wall along which the player cannot build defenses. However, unlike water, mountains do block earthquakes because of their considerable mass.

Mountains are not perfectly safe. While they do block earthquakes, mountains contain hazards

such as landslides and volcanoes which can be even more destructive. Landslides are invisible features which have a certain amount of durability. This health bar is slowly worn away as earthquakes strike the mountain. When this durability is completely depleted, the landslide releases on top of all nearby structures.

Volcanoes come in two varieties. First, are active volcanoes. These mountains are clearly volcanic and show clear signs of eruption. These are dangerous mountains that erupt easily as opposed to their more stable counterparts. Second are the dormant volcanoes. Initially these volcanoes are invisible. The player should have no indication that a mountain is in fact a dormant volcano. However, as the volcano approaches eruption, small indications such as steam, small tremors, and landslides should indicate the mountain's volcanic nature.

Enemy Cities

Enemy cities are points of contention on any map. These cities represent the spawning point of an AI. The AI plays similar to the player, but its main point is to destroy the player. Enemy cities will construct aggressive defenses to divert earthquakes toward the player in any opportunity they are given.

Resource Points

Resource points provide the player locations for expansion. A player may place outposts on these locations to secure the location. After this, the player can harvest the resources at the resource point by building a mine. Resource points are spread around the map so that players will explore and expand.

Player Placeable Features

City

This is the spawning point of the player. The main purpose of the city is to provide the player an initial reason to build defenses. At the beginning of the game, the player has only the city to defend. As the game progresses, the player should be able to upgrade the city to include an airport. This airport allows the construction of helicopter; these are necessary to build outposts.

Cities extend an area of influence around themselves which allows buildings to be built. No defenses may be built outside of this ring. The ring may be expanded by expanding the city by adding modules. These modules' only purpose is to expand the city's area of influence. Only so many modules may be built before the area of influence is at its maximum and will grow no more.

Seismantle

Seismantle is the central object of the entire game. The player uses Seismantle to construct defenses around their city and buildings to protect them from the damage caused by earthquakes.

Seismantle comes in various types, each type offering different advantages to the player. Defenses come in two basic shapes which are, unless otherwise specified, available for each type of Seismantle. These are straight and curved. Straight Seismantle looks similar to a bar of material while curved Seismantle looks like a curved L. Seismantle pieces may not be placed perfectly adjacent to each other. To build complete defenses, players must build staggered defenses. Seismantle is placed in the ground like a wall with most of the mass beneath the ground. Since the player cannot see into the ground, the Seismantle defenses will look similar to short walls.

As earthquakes hit Seismantle defenses, they take damage proportional to the strength of the

earthquake rays hitting the defense. Damage due to each component ray is added up and this total is subtracted from the health of the Seismantle defense. Damage from landslides and lava flows is calculated in the same way, except that landslides and lava flows only have one ray and thus the damage only applies once (of course, this damage is not scaled to the relative toughness of a given defense as are earthquake waves).

These are the basic types of Seismantle defenses: stopping, reflective, refractive, concentrating, and capacitive. Their functions are described below.

Stopping Seismantle

This defense simply absorbs the earthquake rays that hit it. It sustains the most damage per earthquake strength because it takes the full impact of the earthquake every time it is hit. Although it is the least efficient defense, it is the cheapest and is the only defense with which the player begins.

Reflective Seismantle

Earthquakes are reversed by this type of Seismantle. Earthquake rays that hit this defense are reversed and flipped across the normal of the defense exactly as a mirror reflects light. This defense is far more efficient than stopping Seismantle because it takes less damage when hit by earthquake rays of equal strength; however, the reflected waves may cause further damage if the player is not careful.

Refractive Seismantle

Similar to reflective Seismantle, refractive Seismantle redirects earthquake rays that hit it. However, the rays are refracted instead of reflected. This means that rays entering the defense leave at a different angle but still in the same general direction. The angle of refraction is dependent on the quality of the refractive Seismantle which can be increased through research.

Concentrating Seismantle

This form of Seismantle concentrates all incident earthquake rays into a central emission point. The concentrating Seismantle comes in one shape, a bar shape, with a collector side and a concentrated output point on the other side. The strength of the output ray is equal to the sum of all the earthquake rays that hit the collector side. Concentrating Seismantle does not suffer from damage quickly.

Capacitive Seismantle

Energy gained from incoming earthquake rays is stored by this type of Seismantle. Similar to the concentrating Seismantle, the energy stored is equal to the sum of the rays that hit the input side. However, the energy collected in this manner is then stored. A capacitive piece of Seismantle has a maximum capacity after which it will automatically discharge. At any time before this point, the player may decide to discharge the stored charge. This is then released along the normal of the input side.

Outposts

Outposts extend an area of influence around themselves much in the same way as a city. Outposts may be expanded to increase their area of influence; however, the upper limit on expansion is much lower for outposts than it is for cities. Outposts may not build an airport.

Mining Facilities

These buildings collect resources from resource points. Because resources are traded with the main continent, resources are immediately converted into currency for use in purchasing defenses and other buildings. As mining facilities are expanded they increase the income rate, and thus increase the amount of currency available for spending.

Bank

The bank increases the maximum capacity of the currency store. The more expansions built onto the bank, the more capacity is added to the currency store. Multiple banks may be built at each outpost; however, a limit on the number of banks may be necessary to limit the resources at a given maximum.

Generators

Generators provide a given amount of energy per expansion. Every expansion increases the available power. Similarly to banks, this type of building may require a limit on the number built so that a maximum energy limit is established.

Research Buildings

Research points are generated by these types of buildings. They may be expanded upon to increase the research rate and multiple research buildings may be built at various outposts. However, a limit should be imposed on the number of research buildings so that the gain of research points does not become unreasonably fast.

Radar Towers

These buildings reveal oncoming earthquakes before they arrive. They may be built anywhere within the area of a player's influence.

Gameplay Features

Earthquakes

Earthquakes are a central aspect to the gameplay of Refracture. In essence, earthquakes have an origin and an a strength. These are propagated out in a circular pattern from the origin outward. The central idea behind earthquake propagation is that the earthquake itself is a wave emanating out from the origin of many different single rays.

Sufficient rays must be generated so that the effect of the earthquake is notable further away from the source, yet not so many that building closer to the origin will be universally destroyed. As the destruction caused by the waves is cumulative, the magnitude of the earthquake should be distributed among these rays. Finally, as the earthquake ray travels, the strength of the ray will decrease. When the strength of the ray reaches 0 then the ray will cease to exist.

When earthquakes contact obstacles there are many different types of responses. In the case of mountains and stopping Seismantle, earthquake rays deal damage (to landslides/volcanoes in the case of mountains) and then stop. When contacting reflecting Seismantle, earthquake rays reverse direction across the normal with exactly the same strength. Refracting Seismantle causes a similar reaction, except instead of reversing direction, the ray's direction is simply altered by the refractive material. Concentrating Seismantle compounds all incident rays into a single output ray.

For more accurate earthquake modeling, rays could eventually break into component rays whenever a neighboring ray dies. This models the refractive behavior of waves around the edge of materials. In essence, a wave entering through a small opening will propagate throughout the inside region. Thus the player must be certain to cover all gaps in his defenses.

Since earthquakes are so central to the game, they should be generated on a consistent basis.

Unlike reality, earthquakes are a regular occurrence on Fool's Footing, thus an earthquake every few minutes is a reasonable challenge. As the player builds up better defenses, earthquakes should increase in strength and number. The origin of an earthquake is in one of the randomly picked (unless scripted) earthquake origin regions. Within this region, a randomly picked point serves as the absolute origin. Given a random strength, the earthquake is then ready to propagate. As an earthquake spreads across the map, there should be visible cracks/waves in the ground indicating its progress for the benefit of the player.

Landslides

Landslides are associated with a given mountain. Every time this mountain is hit by an earthquake ray, the landslide takes damage equal to the strength of the earthquake ray. The landslide has a given health/durability. When this has been worn away by the damage accrued from earthquakes, then the landslide is released. After the landslide is released, the durability is reset to full and the process begins again. While the landslide will not be explicitly marked on the game map, there should be a visual indication that the ground on the mountain is weakening. The ground should begin to crack and small rocks could occasionally fall down the side of the mountain.

A landslide will travel along the surface of the terrain much similar to an earthquake. However, the landslide will only have one ray. Landslides will not be reflected, refracted, concentrated, or caught in a capacitor. Only stopping Seismantle is effective against landslides, and even that because they are designed to sustain the damage.

Volcanoes

The technical implementation behind volcanoes is very much similar to that behind landslides. volcanoes are given a durability; active volcanoes have a smaller durability than do dormant volcanoes.

As earthquakes wear away at this durability, however, volcanoes give off more signs that they will soon erupt. In addition to visible indications such as steam and ground fragmentation, volcanoes should generate weak earthquakes as they approach eruption.

This could be accomplished by multiple durability characteristics. As one durability bar is depleted, a weak earthquake is generated using the volcano as the origin. Then the next durability characteristic is slowly depleted by further oncoming earthquakes. When all durability bars are worn away, the volcano will erupt. In this way, the player is given sufficient warning that the mountain is a volcano.

On eruption, volcanoes generate a sizable earthquake. This may set off multiple landslides on the surrounding mountains. In addition to this danger, volcanoes can emit flows of lava which act similar to landslides (of course, they are slower).

One final note should be made about volcanoes. Because volcanoes should be obvious to the attentive player, sufficient indication must be given through visual and experiential means. Although a volcano may appear like a normal mountain, it should give off subtle cues such as abnormal fragmenting and steam vents. Landslides should occur more often on volcanoes, meaning that when a volcano spawns, large amounts of landslide objects should be placed around the volcano. This ensures that the player has warning in multiple forms that the mountain is a volcano without explicitly telling him that it is a volcano.

Enemy Cities

Enemy cities are essentially players controlled by the computer. In theory, they deserve a full AI to pose a challenge to the player. At their simplest form, enemy cities should be configured to attack the player and defend themselves. Their defensive patterns do not have to be complex to be effective. All the AI has to do is to pose some form of active annoyance against the player. This adds an extra level of

challenge to the game; not only does the player have to defend against the random assaults of nature, but he must defend against directed assaults from enemy cities.

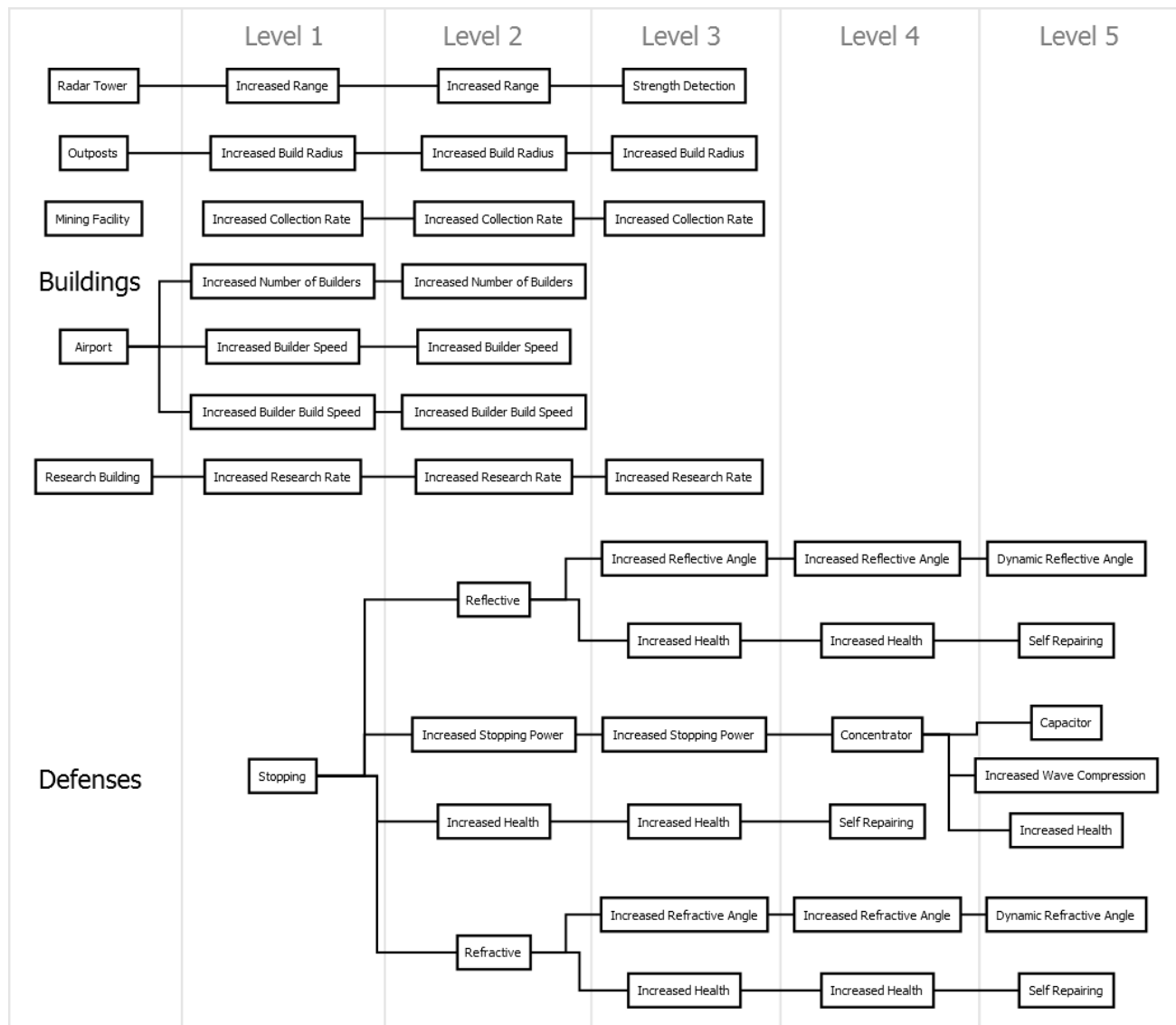
Resource Management

The two resources in Refracture are Money and Energy. Each of these resources act in a very different way. Money provides the raw resources to produce nearly any building/defense in the game. Energy provides the support needed to keep all the buildings in operating order.

Money is gained at a constant rate as indicated at the top of the user interface. Mining facilities increase this rate and building projects decrease this rate. The amount of currency available at any given point is modified by this rate of income. If more is being spent on projects than is being generated by the mining facilities, then this rate is negative and money is lost from the money cache. If no money is available in the cache, then all building projects stop until money is again available. If the cache is full and the income rate is positive, then no extra money is gained. Banks can be used to extend the upper limit of the cache.

The player has as much energy available as his generators can generate. All powered buildings will operate as powered buildings as long as the maximum energy limit is not exceeded. As soon as the buildings require more energy than the generators are generating, then all powered buildings shutdown and begin to act exactly as unpowered buildings (in the case of powered stopping Seismantle, it becomes simply stopping Seismantle). More energy can be generated by building more generators.

Tech Tree



The tech tree is the path along which the player may research new types of Seismantle defenses. A player may research building technologies and Seismantle technologies. Building tech takes the form of expansion. Every time that a new level of expansion is researched, the player can expand his current buildings to utilize that new technology. Expansions have different effects on different buildings as shown in the above tech tree.

Seismantle technology allows the player to build increasing effective defenses. The difference between Seismantle technology and building technology is that, in some cases, Seismantle technology

is automatically applied to the current Seismantle defenses. All Seismantle defenses the same type as the Seismantle upgrade will automatically be upgraded, even if the upgrade requires extra power. Thus, if the player upgrades a basic type of Seismantle defenses from unpowered to powered, he may not have enough Energy to power all his defenses and thus lose the power to all his buildings. This consequence of upgrading requires the player to plan ahead as he progresses along the technology tree.

Outpost Settling

These buildings are built exclusively on resource points. They are constructed by helicopters sent out from the central city's airport. When being built, the outpost takes time to settle, helicopters must be sent from the city to the resource point before construction can begin. After this, construction will last for a set short period of time while the outpost is established. After this, the helicopter can return to the city for its next task. Note that if no helicopters are available, then the outpost may not be built.

Level Design

Basic Level Design

The basic concept behind this game is that the player is presented with a new challenge every time he decides to open a new game. For the most part, worlds will be generated procedurally, providing the player with a great variety of map choices and thus with replay value.

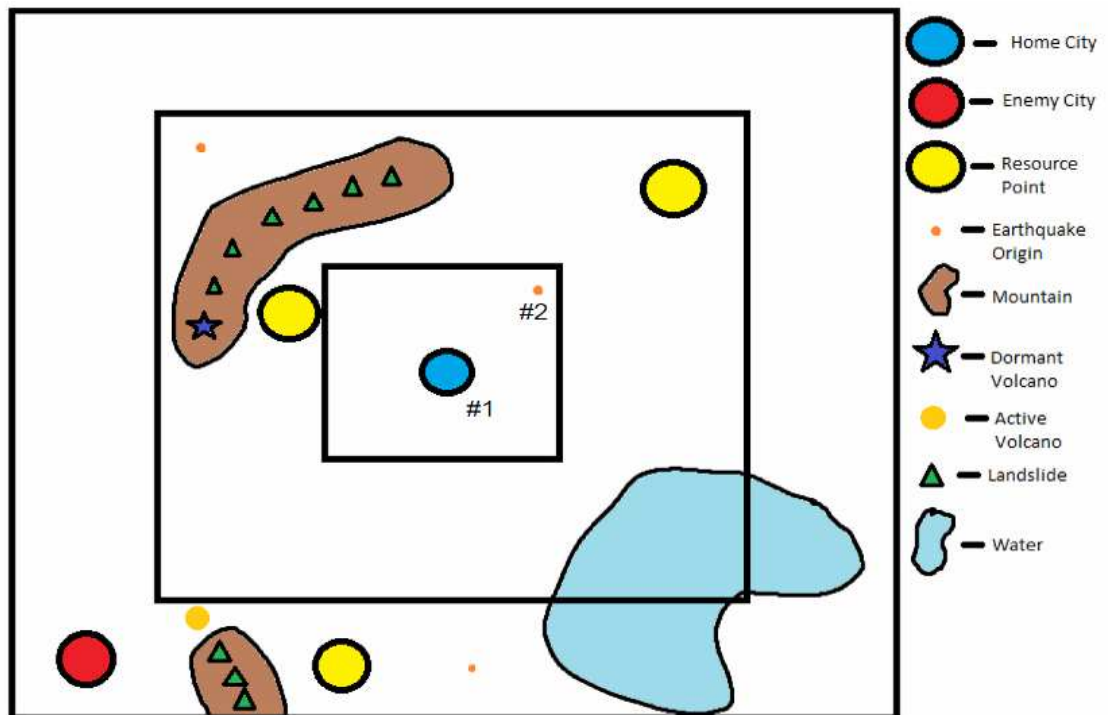
In implementation, the game contains two types of maps. The first, and least common, is the tutorial level, or more accurately, the scripted level. This level is predefined by the game and will be the same regardless of how many times the player plays it. Initially, Refracture should contain only one scripted level; this level is the tutorial. All other levels will be of the second type. The second type is the procedurally generated level. Elements on this map are placed as the player begins a new game.

Scripted Levels

These types of levels are completely defined by the game before game play. They are stored in a map file which contains information about terrain placement, earthquake generation regions, player starting points, and other scripted events.

In theory, the game framework should be flexible enough to allow further development of scripted levels so that a campaign could be added in a later release. However, scripted levels are not the focus of the game. The only reason that the initial game is concerned with scripted levels is that the tutorial will run as a scripted level.

Tutorial Level



This level is used as an introductory tutorial on what things are in the game and how they affect the game. There are three main areas in which the level takes place; the first few objectives are completed in the beginning area, after which the map expands until more objectives are complete and you have the entire map open. The purpose of the expanding level is to teach the player about certain aspects of the game at an easier pace set mostly by how fast the player wishes to advance.

The first zone will be an introduction to the game, with the player's city, represented by the #1 on the design, near the origin of an earthquake, represented by the #2 on the design. The player will learn the basics of what they can do in their city, namely building and placing SeisMantle to defend themselves from the approaching earthquake not far from their city!

The second zone of the tutorial spans an area that includes some mountains, some resource points, and a dormant volcano within a “mountain.” The player also sees part of a body of water. The intent of this section of the tutorial is to explain more of the environment for the benefit of the player.

Resource points are locations which the player can secure in order to gain a faster income of money and energy to use at their disposal. The water and mountain are primarily obstacles, restricting expansion in those direction, but the mountain has more dangers involved with it... The first and most immediate is the possibility of landslides. If enough earthquakes hit a mountain, the earth will crumble down on anything near it. In truth, the mountain is actually a dormant volcano, and under the influence of the seismic waves and shifting plates, there's no telling when it could become active and erupt. There are initially no signs of a mountain's volcanic properties, but as it becomes more active, the signs begin to show.

The third and final zone of the tutorial spans out to an area including more resources, some water, and small bit of mountain area. This part of the tutorial teaches the player of more advanced SeisMantle. Here the player is introduced to another city, but they are NOT friendly; they are actually bent on the destruction of the player's city! Another powerful threat rears its ugly head at this zone in the tutorial: an active volcano. The best bet with those is to just steer clear of them completely. The overarching mission in this tutorial is to survive the threats of Fool's Footing and put an end to the enemy city.

Procedural Levels

These are the mainstay maps for Refracture. Most games that the player plays will be procedurally generated. In essence, a procedurally generated map divides the map into sectors and places a random amount of terrain elements in each sector. Thus maps are generated on a sector based system.

The initial sequence of generation places the player starting point and the resource points. These points should be roughly distributed throughout the entire map. This spreads the points of strategic interest across the map so that the player must explore and expand throughout his environment. One

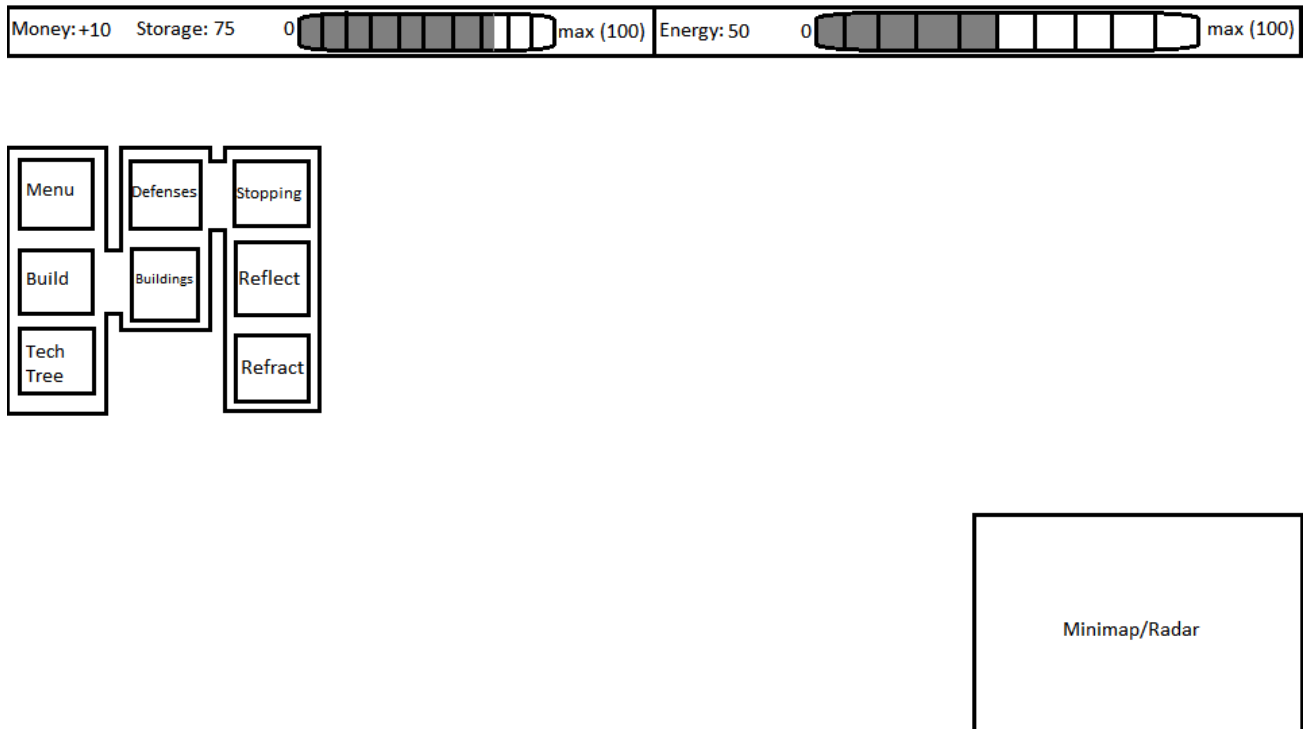
algorithm that may solve this issue is a weighted quad-tree where each branch of the tree is weighted by the number of points it currently holds. New points could then be placed where there is the least weight on a branch.

Following the initial sequence of generation, other terrain should be placed. Since terrain should not be placed on top of other features (such as the player starting point or resource points), some method of preventing terrain overlap should be implemented. One such algorithm is a Voronoi diagram. Since this results in a point map, the use of a Voronoi diagram would allow placement of mountains and other terrain features in contiguous regions between these points.

In the case of mountains, Voronoi diagrams would allow a mountain range to randomly choose a number of contiguous edges. These would then serve as the guiding region for a placement of a range of mountains. In this way, the map begins to take on meta-characteristics (with mountain ranges, valleys, and other recognizable features).

User Interface

Screen UI:



On the top of the screen are the resource storage and gain meters. On the left is the Money gain and storage bar. The gain is represented by a positive or negative number representing how much Money is being gained or lost every second. The bar is the storage for Money. It begins at zero and goes up to the maximum which is set by the number of Banks the player has built. As the player stores more Money, the storage bar increases until the gain either becomes zero or negative or the maximum amount of Money is stored.

On the top right of the screen is the Energy storage bar. The Energy storage increases as more Generators are built and is a linearly increasing or decreasing amount. As more generators are built, the maximum amount of possible Energy used is increased. Different structures require differing amounts of Energy and the total Energy usage is represented by how full the bar is.

On the left-hand side of the screen is the build menu. This is a series of expanding menus. As one is selected, its corresponding sub-menus are shown.

In the bottom right-hand corner is the minimap. This is an overview of the map which allows you to see all that you have discovered on the map as long as you have buildings to push back the fog of war. This also shows your radar sweeps which give you early warning of incoming earthquakes.

Tech Tree UI:

(See Page 12)

Along the top of the screen is the Level classification. This is a quick glance of how deep in the Tech Tree the specific technology is. Along the left-hand side, you can see which building the upgrade is for. Each box is a different technology that provides a different improvement for whatever building or defense it is under. The lines between the boxes represent which technologies are prerequisites for other technologies. Lower Level technologies are required to move into the higher Level technologies. In the bottom left-hand corner is the number of available Tech Points that you have to spend. Each Level of technology requires more Tech Points so the deeper in the tree the technology is, the more Tech Points it costs to research. The Tech Tree can be side-scrolling if the Tree is too large to fit on the screen at the same time.