Phase 1

Team Fractal

Contents

Section 1

Requirements

1.1 Background

1.1.1 Elicitation and Negotiation

Requirements are fundamental to the software engineering process. In order for us to deliver a piece of software which is as close to our customers vision as possible, we needed to begin the requirement engineering process, starting with elicitation. We first analysed the brief as a team, and made a note of all the requirements which were clearly stated. We also highlighted parts of the brief which we thought were ambiguous and needed further input from the customer to ascertain what they required more precisely. We took these points to an interview with the customer to gain further insight into what they required. At the interview, the customer told us that we could decide what we thought was best for some of the details, such as the exact features of the map, and the amount of customisation that can be applied to a plot. We looked at all of these as a team and decided on an initial plan of what these should be.

We compiled all of this into the first draft of our requirements, with a section for those things which would be nice to have, but were not essential according to the brief. This means that if we need to revisit our requirements during development because otherwise we would not be able to complete the project on time, we know which requirements can be changed or toned down to allow for this.

We took this first draft of the requirements back to the customer, and together we went through them all to ensure that we were agreed on what the requirements were.

1.1.2 Presentation

We will be using user stories, as detailed in Sommerville [1], these stories will detail the needs of the user for specific features and aspects of the system. We are using user stories as they are part of the agile development process and easily allow for us to iteratively adapt to change. This is useful the requirements themselves change or if we realise we need to update them due to contradictions. The user stories will also include acceptability criteria, this means that we will be easily laid out everything the system needs to be able to do. This will also feed into the test driven development we will be using later in the project as we able to see if a requirement has been fully implemented. We will not be using use cases as they are part of none agile development methods and more suited to transactional processes and are therefore inappropriate for this project.

We will then tabulate our requirements to make them more accessible to us and to the customer. In the table we will have the number and name of the user story to allow us to easily reference them. We will then have the user story itself. Finally, we will have the acceptance criteria split up into functional and non-functional requirements. When referencing requirements they will be referred to by a series of 3 numbers separated by points. The first number will represent the position of the user story associated with the requirement in the requirements table. The next number will show if the requirement is functional, represented by a 1, or non-functional, represented by a 2. The final number will represent the position of the requirement in its cell in the table. We chose to tabulate our requirements after initially presenting our requirements to the customer as a user story followed by a list but changed them as he said it would be easier for both himself and us to read and reference.

1.2 User Stories

#	Title	Story	Functional	Non-functional
1	GUI	As a player I must be able to see a GUI consisting of a map subdivided into plots and should be able to gain information about the state of my freehold and my individual plots.	1.1.1. The entire map should be available to the user 1.1.2. Information about individual plots should be shown: (a) Which player owns a plot (b) Output of ore, energy, and food (c) Robiticons installed	1.2.1. The map must represent the university of York with at least 3 identifiable landmarks 1.2.2. The map must be split into multiple evenly sized plots 1.2.3. Each player must be uniquely identifiable on the map
2	Purchasing Land	As a player I must be able to purchase plots of land to increase the size and productivity of my freehold	2.1.1. The player must be able to exchange currency for more land during the acquisition phase of the round	2.2.1. Plots will have different strengths and weaknesses in terms of production based on location and terrain type 2.2.2. These values can change when random events occur 2.2.3. All plots are unallocated at the start of the game
3	Plot Modification	As a player, I must be able to buy and sell various modifications to my plots to increase productivity and/or style.	3.1.1. The system must provide a number of possible modifications to plots	
4	Multiplayer	As a player, I must be able to buy and sell various modifications to my plots to increase productivity and/or style.	4.1.1. A player must be able to chose whether to play against another human or the computer 4.1.2. At least two users must be able to play the game together 4.1.3. The players will take turns in playing	

#	Title	Story	Functional	Non-functional
5	Round Structure	As a player I must be able to play the game in a structured manner	5.1.1. The game must be split into multiple rounds 5.1.2. Each round should be made of 5 phases: 1. Purchase any unoccupied plots 2. Purchase and customise roboticons 3. Install roboticons on plots of land 4. The colony produces resources 5. The player can buy and sell resources 5.1.3. Phases 2 & 3 must be time limited.	
6	Roboticons	As a player I must be able to purchase and customise my roboticons so they can produce more of certain amounts of resources	6.1.1. The player must be able to purchase roboticons from the market 6.1.2. The market must have ore to produce roboticons 6.1.3. The user must be able to purchase modifications for the robiticon at the market 6.1.4. The user must be able to install modifications on roboticons 6.1.5. The user must have the option to install a roboticon on a plot of land they own.	6.2.1. At the start of the game, the market has 12 roboticons

#	Title	Story	Functional	Non-functional
7	Resources	As a player I must be able to produce resources from my plots	7.1.1. Roboticons are required to produce resources 7.1.2. During phase 4 the users roboticons will generate resources across the freehold 7.1.3. Food, energy and ore will be generated 7.1.4. Different amount of resources will affect the rate of production	
8	Buying/selling resources	As a player, I must be able to buy and sell resources to other players through an auction, or to the market at a fixed price so that I can maximise my wealth and productivity.	8.1.1. The system must provide an auction facility, where the other player and the market bid for resources 8.1.2. The system must choose a market price based on resource abundance 8.1.3. The player must be able to buy/sell resources from/to other players, or the market	8.2.1. At the start of the game, the market must have 16 units of food and energy and 0 units of ore 8.2.2. At the start of the game, the player must have a small amount of money
9	Gambling	As a player, I must be able to enter the bar and either win or lose money.	9.1.1. The system must provide a minigame where the player can gamble with their money	
10	Winning	As a player, I must be able to win or lose the game.	10.1.1. The system must assign a value to each resource at the end of the game, from which a player's final wealth is calculated 10.1.2. The game must end on the round in which the last plot of land has been allocated. 10.1.3. The player with the highest final wealth must be declared the winner, and Vice-Chancellor of the colony	

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[1] I. Sommerville, *Software Engineering.* Harlow, United Kingdom: Pearson Education, 10 ed., 2016.

Section 2

Architecture

2.1 Proposed Architecture

2.1.1 Introduction

In this project we will be designing the architecture for our game, and its achieved by using lucidchart for UML diagram drawing. The reason for choosing this tool, simply because it have those necessary symbols already predefined, it also gives us the ability to work on diagrams collaboratively. We will be using UML 2.X specification.

2.1.2 Abstract System Architecture Overview

An abstract UML class diagram is provided as Figure 2.1

2.1.3 Entities

We have identified the following classes that will be used in our system:

Engine	The game engine itself, in charge of communications between classes.
Player	The player entity has 2 child classes - AI and Human. Both have same base method and property names, with some different method bodies.
LandPlot	Each instance of this class will represent a single tile on the map
GameMap	This class is controlled directly from the engine. It stores all LandPlot instances.
Roboticon	Roboticon is used in LandPlot for resource generation, trade between the player and the market.
Market	The trading center. Players can buy or sell different types of resources and roboticons. It connects with the minigame class.
Minigame	This class content a minigame for gambling, it is connected to the Market.
Auction	The auction system, each instance will handle an individual auction that involves specific or selected players.

2.1.4 Collaboration Diagrams

These are collaboration diagrams which show how the classes in our game will interact to complete various tasks. They also allowed us to test our class diagram and ensure that all necessary relationships had been established. They are provided as Figures 2.2 to 2.9.

2.2 Systematic Justification of Architecture

Designing an abstract representation of the system architecture required a lot of thought from the team, as it is easy to overlook important relationships between classes and objects. We began the design process by looking through the brief and our requirements document and creating a list of classes that we felt encompassed the fundamental game elements. From this process, we came up with the entities shown in

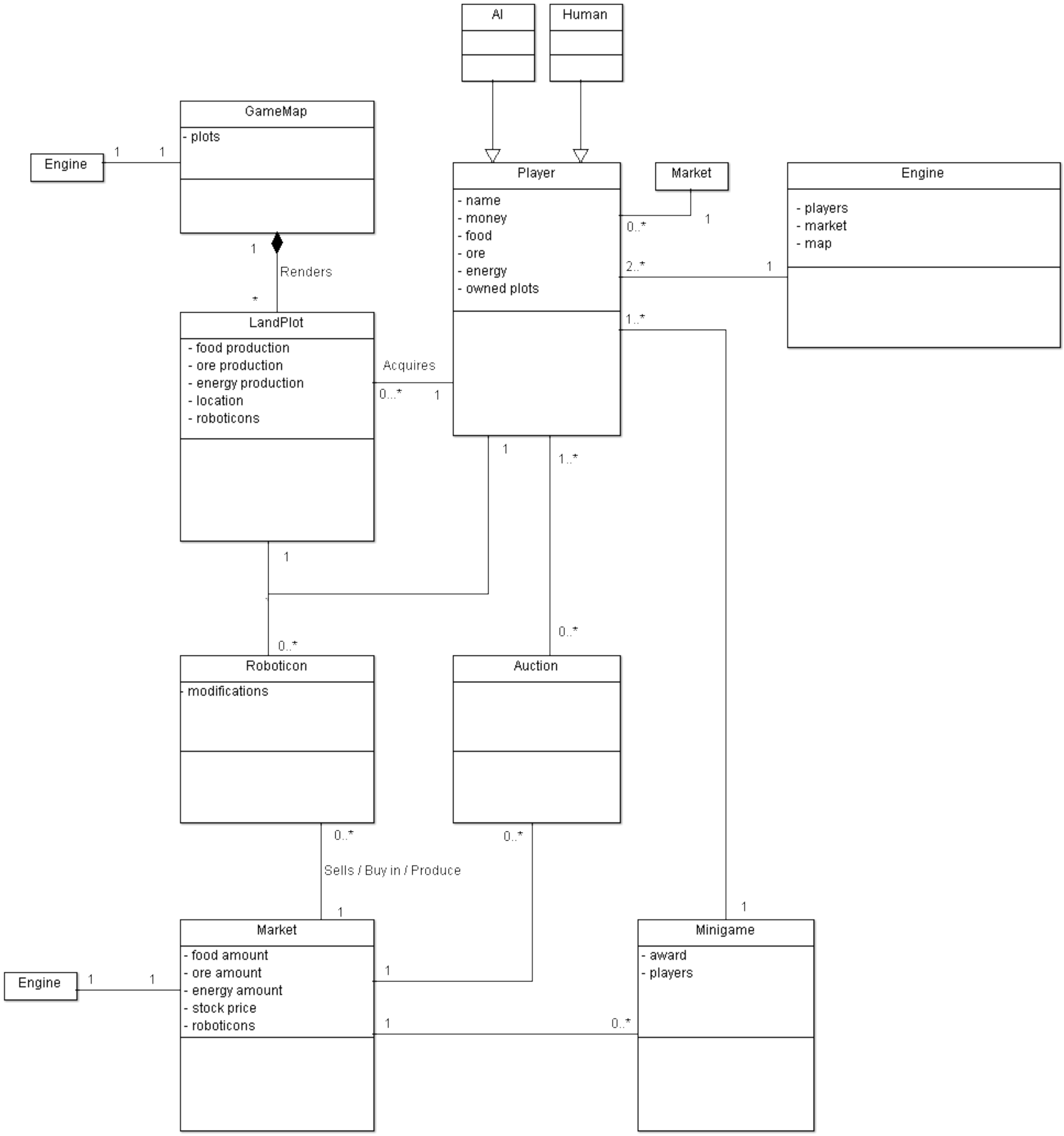


Figure 2.1: Abstract UML class diagram showing the relationships between classes in the software

Figure 2.2: Collaboration Diagram: Buying a plot of land

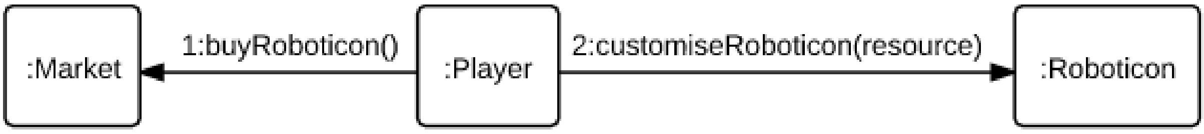


Figure 2.3: Collaboration Diagram: Buying/Customising Roboticon from Market

Figure 2.4: Collaboration Diagram: Roboticon Installation

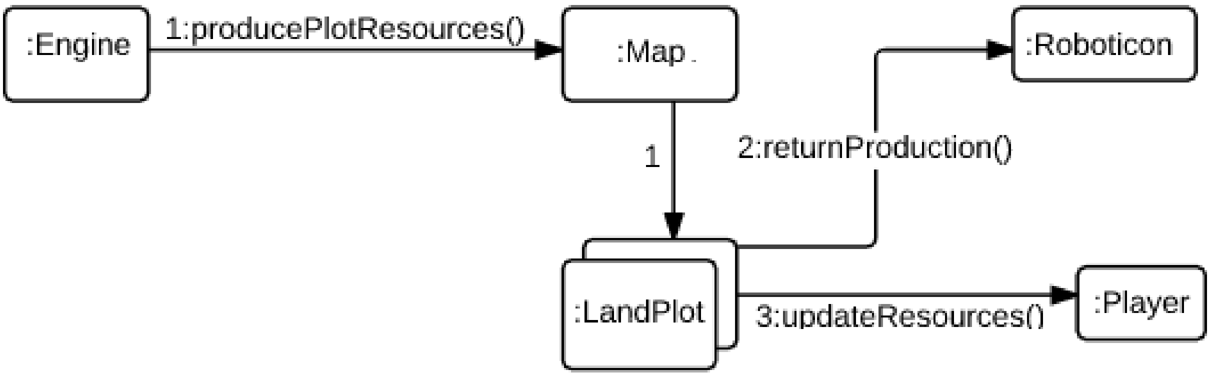


Figure 2.5: Collaboration Diagram: Production of Resources

Figure 2.6: Collaboration Diagram: Buying from Market

Figure 2.7: Collaboration Diagram: Selling to Market

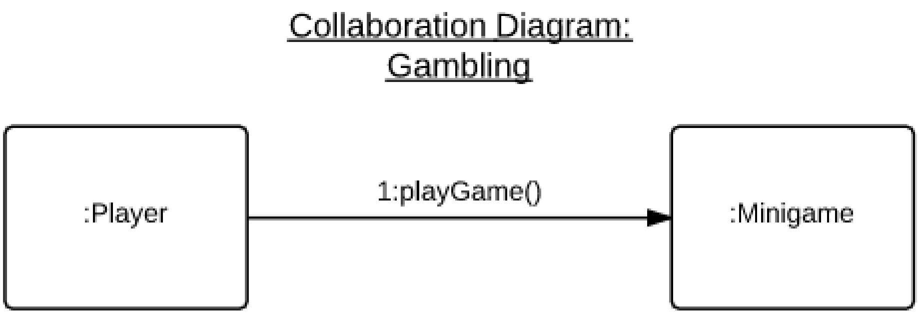


Figure 2.8: Collaboration Diagram: Gambling

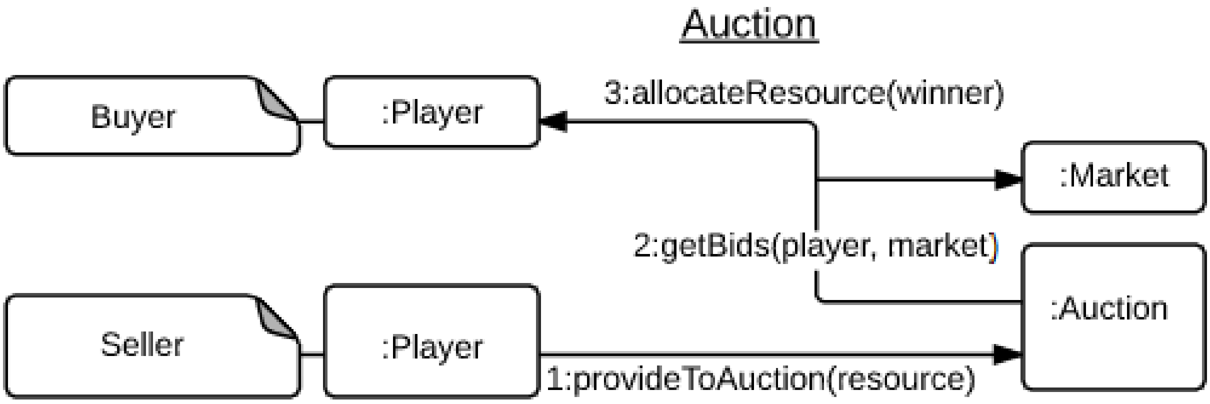


Figure 2.9: Collaboration Diagram: Auction

the table above. Below is a description of how each class will work and justification for why it will work that way.

2.2.1 Engine

The game engine is a particularly important class, as it is responsible for initiating and controlling each phase of the game, as well as invoking random events which will affect the games current state. In order for the Engine to be able to do this, it must be able to communicate with the other fundamental classes, these being the GameMap and each instance of the Player class. From the brief, we established that there is a one-to-one relationship between the Engine and the GameMap, and a one-to-many relationship between the Engine and the Player (we have set the number of instances of player to be two at the moment). The Engine doesnt need to be connected to other classes such as the Market and the LandPlot as these can be accessed via GameMap and Player. We chose not to give many classes a relationship with the Engine, as this will create too many class couplings, meaning that if we need to make changes in the Engine class, changes will need to be made in many other classes too.

2.2.2 Player

The player class models each player in the game, and the set of decisions that they can make while playing. These decisions include: buying plots of land, installing roboticons on plots, buying and selling from the market, and gambling in the bar (as detailed throughout the requirement section). Because of the players large range of actions in the game, we needed the player to have relationships with quite a few of the other classes, including the Market, the Auction, various instances of the LandPlot class, and the Minigame. Although this may seem risky due to the slightly monolithic nature of the class, we feel that the only way we can deliver a piece of software which satisfies all of the requirements is to design the system in this way. The Player class will be the parent of two other classes called Human and AI. These classes will inherit the attributes and methods of player, but will overwrite methods to suit each player role. The player will have attributes detailing the name of the player, as well as the amount of money they have, the number of each resource they own (food, energy, ore), and the plots they own.

2.2.3 Roboticon

The roboticon class is responsible for production of resources on a plot, as stated in requirement 7.1.1., and any modifiers that will be applied to the rate of production. It is therefore necessary for a roboticon to be able to communicate with the land plot on which it is placed. In accordance with requirements 6.1.4. and 6.1.5. the player will be able to customise the roboticon by installing upgrades for money. Finally the roboticon is produced, stored, and sold by the market so the classes must be able to communicate, as described in requirements 6.1.1 and 6.1.2.. It will have attributes to determine how it will alter the production of resources on a plot.

2.2.4 Market

The Market is the class responsible for managing the price of resources in the game (based on supply and demand), and also producing roboticons, as specified in requirement 8.1.2.. The player can directly buy and sell resources to/from the market so must be able to interact with it. The market will also engage in the auction, placing bids against the other player and affecting the price at which resources are bought and sold. It will therefore interact with the auction. The market also has a relationship with roboticons as it can buy sell and produce them.

2.2.5 Minigame

The minigame is a fairly simple class as it only interacts with the player. The minigame is a game found in the market which will allow the player to gamble and either gain or loses money which will satisfy requirement 9.1.1.

2.2.6 Auction

The Auction Class is responsible for players buying and selling resources to each other, as described in requirement 8.1.1. The market will also act as a bidder in the auction giving bids based on the supply/demand of the resource allowing access to the auction in a 2 player Game. The auction will take resources to be sold from one player and bids from the other player(s) and the market, then provide the resources to the highest bidder.

2.2.7 LandPlot

The LandPlot class is used for purchase, resource production and customisation as Player request as described in requirement 2, 7.1.3 and 3.1.1. All LandPlots instances are stored inside the GameMap class for rendering, and those LandPlots shall have the same size as described in requirement 1.2.2. On the occurrence of random event, the production rate for different resources should change respectively if criteria matches per requirement 2.2.2.

2.2.8 GameMap

The GameMap Class is in charge of storing all instances of LandPlot and the interaction with the Engine to render the Game Map to the screen. At beginning of the game, GameMap will initialise and set all LandPlots to a state of unoccupied to allow the Player to view and purchase as described on requirement 1.1.1 and 2.2.3.

Section 3

Method Selection and Planning

3.1 Outline and Justification of Software Engineering Methods and Tools

Choosing a set of software engineering methods for our SEPR project has required careful consideration from us as a team. Many factors can influence the suitability of certain methods for a project, such as team size, the type of system being delivered and the volatility of user requirements. It was through the analysis of these type of factors that we came to a decision about which methods we would be using.

A key aspect of a software engineering method is its development lifecycle, which dictates and characterises each engineering activity. Many different lifecycles exist, with varying characteristics, so it was important for us to explore some different types and decide which one was best for our project. We decided that methods based on an incremental development lifecycle would be most suited to us, as it protects us against volatile requirements and allows us to regularly get feedback from our customer. This means we can produce an end result which is as close to our customers expectations as possible. We explored alternative lifecycles to the incremental approach, including the waterfall approach proposed by Winston Royce [1]. We discarded this approach however because the model struggles to deal with changes of requirements, and also has large documentation overheads which are not necessary for the size of our project. There is also risk involved with this model as the first time the customer sees the software is at the end of the lifecycle, so if they are not satisfied then it will be very hard to fix broken procedures and implement new ones.

Now that we had decided on our development lifecycle, we next had to decide on a set of engineering methods and principles which fit the incremental approach. Once again, there are a large number of methods which fit this approach so an investigation of these methods and their differences was required.

We looked at the Rational Unified Process (RUP) proposed by Rational, now a division of IBM, which is a plan-based incremental engineering method. RUP splits each iteration of the development lifecycle into four phases, called the inception phase, elaboration phase, construction phase and transition phase. Each phase has a well defined milestone which is achieved at the end of the phase [2]. The first two phases involve the creation of a requirements list, use cases, risk assessments, project plans, a system architecture amongst other planning phase documents. The next two phases are all about the development, testing and integration of the system into the customers working environment. After evaluation and consideration, we decided that RUP wouldnt be best suited to our project. The problem we found was that in order to use this development process, you need strong knowledge from the outset of how the system will work in order to develop the use cases. While we have been given a brief, from interviewing our customer we discovered that certain features have been left up to us to develop, meaning that working through the first two phases of RUP in each lifecycle would be difficult and cost us time, leaving us with less time to actually develop the software. Also, according to Boehm, only change rates on the order of 1% of the requirements are acceptable for plan-based development [3, p 31]. With our project, requirements may change on a regular basis, meaning that this approach may not be able to cope.

We decided instead to adopt an Agile approach to the software engineering of this project due to its merging of design and implementation phases and short iteration lifecycles which will allow the system to organically grow as we incorporate customer feedback into the development process. We will mainly be following the eXtreme Programming (XP) and Scrum agile methods, as the principles in each method work very well for small teams who can stay in regular contact with their customer, which is perfect for us. Some of the principles from the eXtreme Programming agile method that we will be using in the development of our project are:

- Test Driven Development (TDD)
- Refactoring
- Incremental Planning & User Stories
- Pair Programming
- Small releases & updates of the final product [4]

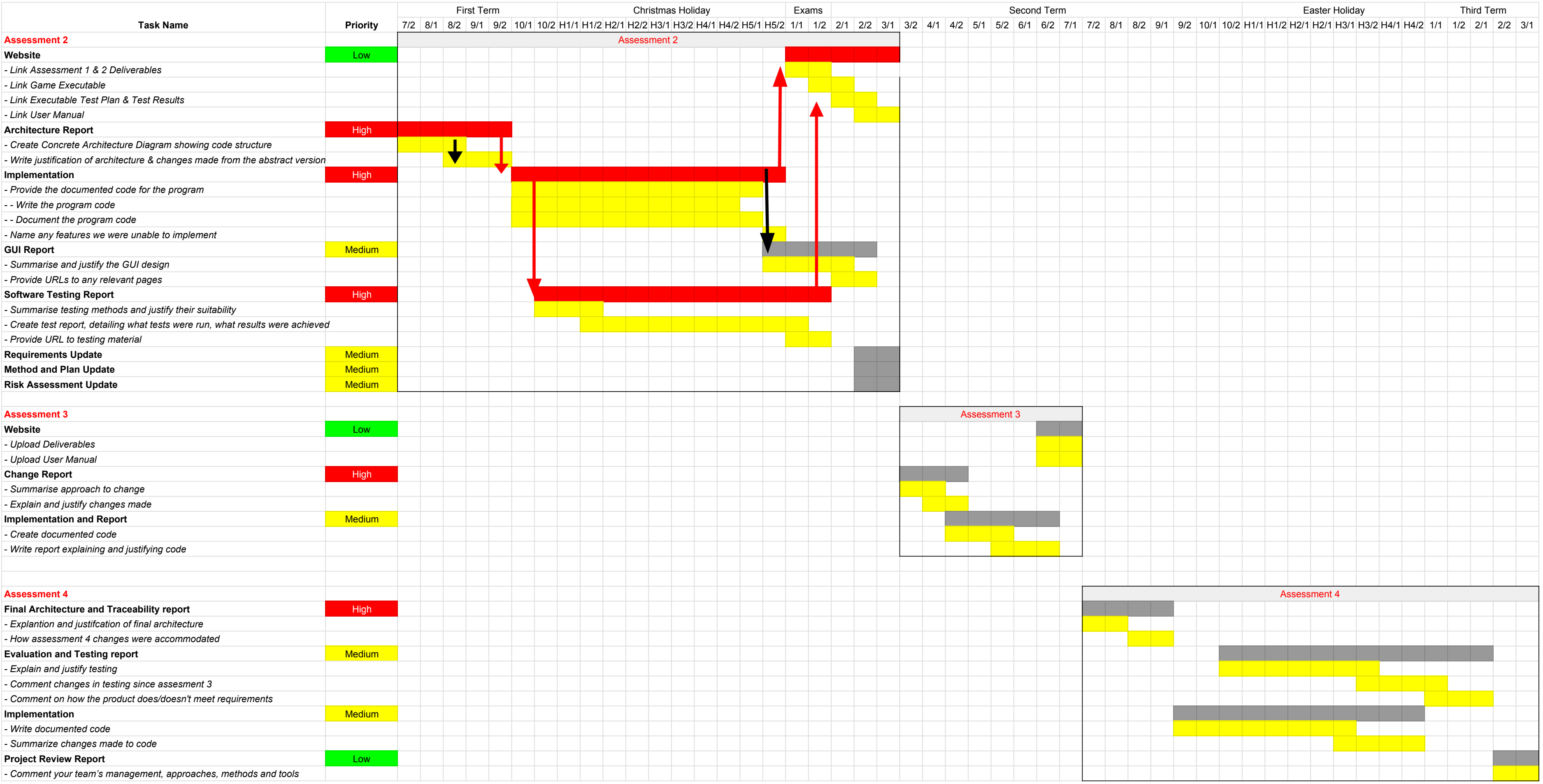
In order to write code and collaborate as a team, we are going to need a version control system. Git seems like a suitable option, as it allows us to work on different sections of code together in local repositories before committing updates to the main repository without blocking each other's productivity. A good team also requires good communication, so we will be using the Slack service as it allows us to talk on multiple channels, and integrate other services into conversations (e.g. Git commits and updates). Organising tasks which need to be completed is another important part of collaboration, and Trello provides a very nice way of doing this. We can set up different cards on a Trello dashboard for different backlogs of task, meaning that we always know what needs to be completed, what is being completed and what has been completed.

3.2 Team Organisation

Team organisation can be the difference between a successful project and a failure, so we took the time to choose an approach to organisation which will allow the team to collaborate effectively, and reflect on improvements we need to make as a team in order to be successful. The Scrum methodology seems like an excellent way to organise the team, and fits in well with the other Agile methods and principles we are using e.g. user stories from eXtreme Programming [4].

We will begin each iteration of our software lifecycle by reviewing our current user stories and breaking them down into tasks which can then be implemented into the system. Test cases can also be generated from these stories for Test Driven Development. We will have a Trello dashboard with cards for the Product Backlog and the Sprint Backlog where all the tasks and the current sprint tasks respectively will be stored, allowing us to move tasks from the left to the right as they are completed by the team. Once the tasks we are completing during the sprint have been established, we will carry out the sprint which will last for around 4 - 5 days. During this time we will attempt to implement as many of the tasks in the Sprint Backlog as we can, as well as having a regular meeting each day called a Scrum where we say what we are working on, how we are getting on with it, and if we are having any issues. After the sprint is finished, we should ideally have a version of our system that is working and includes all of the functionality we have implemented so far. We will then have a sprint review, where we discuss how the sprint went, if there is any outstanding functionality which wasn't implemented during the sprint and if there are any ways in which we can improve team productivity.

3.3 Project Plan



Arrows show the dependancies between tasks.
The critical path is shown in red (this diverges because writing the code and testing will be happen concurrently).

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[2] Rational, IBM, "Rational unified process: Best practices for software development teams." [online] Available: `https://www.ibm.com/developerworks/rational/library/content/03July/1000/1251/1251_bestpractices_TP026B.pdf`, 1998. [Accessed: Oct 23, 2016].

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Section 4

Risk Assessment and Mitigation

4.1 Introduction

Throughout the project we will face a number of potential risks however we will do our best to mitigate them. When analysing the risks we will focus on two factors, likelihood and severity.

A risk can either have a high, medium, or low chance of becoming a reality. If a problem is not likely to occur when running a project three times or more we deem it to have a low likelihood. If it is likely to occur once during the project or when running a project twice we deem it medium likelihood. Finally, if it is likely to occur multiple times during the project, we will deem it as high likelihood.

A risk can also either be high, medium, or low in severity. A high severity risk could result in months of lost progress up to having to totally start over. A medium severity risk could result in the loss of between one week and a few weeks of progress. Finally a low severity risk would only result in a maximum of a few days of lost progress.

To combine these two factors into something meaningful we will use a risk matrix (Figure 4.1). This will allow us to find a balance and identify the risks that will pose major problems.

		Likelihood		
		Low	Medium	High
Severity	Low			
	Medium			
	High			

Figure 4.1: Table showing how likelihood and severity of a risk combine to show overall impact of the risk

Green cells in the matrix are considered to be overall low risk, this is because they are not particularly likely to happen and if they do they will not have be severe enough to majorly impact the project. Orange cells signify an overall medium risk. They are either likely to happen but low severity, very unlikely to happen but would have a very severe impact or somewhere between. Overall high severity risks, red cells, are the most important to mitigate. They have a reasonably high chance of happening and could result in the loss of weeks or months of work.

It is important to categorise risks once they have been identified so that we can prioritise mitigation, it is imperative that overall high risks cannot happen and in the case that they do we must be able to cope with them and have protocols in place to lessen the impact.

We will be presenting the risks in a risk register with columns identifying, analysing and showing the mitigations for the risk. This will give us an accessible and easily modifiable document which we will be able to use throughout the project when considering or attempting to mitigate risks.

4.2 Risk Assessment

Category	Name	Severity	Likelihood	Overall	Mitigation	Contingency
Staff	Team member leaves	High	Low	Medium		
Staff	Staff sick or unable to attend meetings.	Medium	High	High	Let other members of the team know as soon as possible	Other staff takes over their work temporarily.
Staff	Dont have the skill required to complete the task.	Low	Medium	Low	Research the skills needed. Ask other team members if they know how to help.	Read books and the internet about required skills.
Staff	Staff dont listen others opinion	Low	Low	Low	More communication, consult Richard/Fiona if the problem continues.	Stay together and work out the root reason, then resolve it.
Staff/Requirements	Staff failed to complete the task before deadline.	High	Low	Medium	More rapid sprint to ensure everyone is on track.	Cut our optional features and complete the compulsory requirements first.
Requirements	Change of requirements	Low	High	Medium	Keep in touch, build and show to the client	Update the requirement document and update the product.
Requirements	Responsible of telling the customer that requirements were impossible and offer alternative options.	Low	Low	Low	Negotiate with the customer before updating the requirements.	Explain to the customer what has to be changed.
Requirements	Cannot meet the requirement	High	Low	Medium	Design realistic requirements before start coding.	Modify the requirements so it can be met.
Tech	Data lost - e.g. hard drive failure.	Medium	Low	Low	Backup data regularly to cloud or different devices.	Restore most recent backed up data.
Tech	IT facility failure	Low	Low	Low	Routine maintenance to devices.	Use campus computer to continue development.
Tech	Security threats	High	Low	Medium	Install antivirus software and enable firewall.	Seek IT support for help and continue working.
Tech	Software bug that causes data loss.	High	Medium	High	Backup data before executing dangerous commands.	Reset to the previous commit using git.

Category	Name	Severity	Likelihood	Overall	Mitigation	Contingency
Tools	Tools not available	Low	Medium	Low	Research background information about alternatives before proceeding.	Switch to an alternative tool, request help from IT support or create one if enough time before deadline.
Tools	Unfamiliar with the toolset.	Low	Medium	Low	Learn how to use the tool.	Ask IT support or other teammates for help.
Tools	Tools does not fit into the project after start off.	Low	Medium	Low	Do extensive research and comparison before integrating to the workflow.	Find alternative and re-evaluate options.
Estimation	Estimates that there will not be enough time to finish the whole project.	High	Medium	High	Allocate and plan the time efficiently.	Plan and spend more time for the project.
Customer	Customer changes the requirements.	Low	High	Medium	Keep in touch and understand the necessary changes as soon as possible.	Examine new requirements and update them accordingly.
Customer	Customer doesn't allow or understand why we have to change the requirements.	Medium	Medium	Medium	Keep in touch with the customer	Sit next with the customer and talk through the reason why.
Test	Bugs discovered	Medium	High	High	Understand the code and have comments around them.	Fix bugs.
Test	Something wrong but cannot find the errors.	Medium	Medium	Medium	Put comment around the code to describe, and do tests.	Debug the problem using a debugger and seek for help.