

Bachelor's thesis

Information technology

NTIETS12P

2017

Jami Andersson

# COST-EFFECTIVE GAME PROTOTYPING FRAMEWORK

– Subject 54 prototype

BACHELOR'S THESIS | ABSTRACT

TURKU UNIVERSITY OF APPLIED SCIENCES

Information Technology – Game technology

2017| 44

Instructor: Principal Lecturer, Mika Luimula, Adj. Prof.

Jami Andersson

# COST-EFFECTIVE GAME PROTOTYPING FRAMEWORK

- Subject 54 prototype

The purpose of this thesis was to create a cost-effective framework for prototyping for the commissioning customer. The framework would work as a guideline that could be utilized when planning the prototyping. To support the framework, an additional prototype was created for PC platforms. The focus of this thesis was to review the basic of prototyping and the tools used for it. When creating the framework, local game businesses prototyping practices were examined and compared with each other.

This thesis provides a general introduction to the prototyping process. In addition local game business representatives were interviewed to find out how they handle prototyping generally and project-wise.

The additional PC prototype was developed by using the tools selected by the commissioning customer. The prototyping consisted of three different phases. The planning phase included compiling technical documentation that contains detailed information about the contents of the prototype. The development phase was based on this documentation. During the development phase, the prototype was created using the game development tools. Publishing was last phase in which the prototype was tested and feedback was collected.

Data collected from the interviews and the additional PC prototype was used to create the framework. All the required phases to create a prototype are included in the framework. Cost efficiency is the main focus of the framework.

As a result the framework will be utilized in the next suitable project. The framework can also be customized for specific projects. The additional prototype went successfully through all three phases and is now currently available for free. The customer can later on decide whether they want to develop the prototype further or not.

## KEYWORDS:

Prototyping, game development, Unreal Engine 4, cost efficiency

Jami Andersson

# VIITEKEHYS KUSTANNUSTEHOKKAASEEN PELIN PROTOTYYPPIPAUKSEEN

- Subject 54 prototype

Työn tavoitteena oli luoda viitekehys pelien kustannustehokkaaseen prototyypin pakukseen. Viitekehys toimisi eräänlaisen ohjenuorana, jota voitaisiin käyttää työkaluna prototyypin pakusta suunniteltaessa. Tukemaan viitekehystä työssä kehitettiin myös oma prototyyppi PC alustalle. Työssä keskityttiin käymään läpi prototyypin pakuksen perusteita ja siihen käytettäviä työkaluja. Viitekehystä luodessa tutkittiin paikallisten pelialan yritysten prototyypin pakuskäytäntöjä ja vertailtiin niitä keskenään.

Prototyypin pakukseen perehdyttäessä tutkittiin prototyypin pakusta yleisesti ottaen. Lisäksi haastateltiin paikallisten pelialan yritysten edustajia ja pyrittiin selvittämään yritys sekä projekti kohtaisesti miten prototyypin pakaminen suoritetaan.

Oma prototyyppi luotiin käyttämällä toimeksiantajan valitsemaa pelinkehitys työkaluja. Prototyyppi kokonaisuudessaan muodostui kolmesta eri vaiheesta. Suunnitteluvaiheessa prototyypistä kirjoitettiin dokumentaatio, jossa käytiin läpi yksityiskohtaisesti prototyypin sisältö. Dokumentaation pohjalta aloitettiin kehitysvaihe, jonka aikana luotiin itse prototyyppi pelinkehitys työkaluja käyttäen. Viimeisenä oli julkaisuvaihe, jossa prototyyppi testautettiin ja aloitettiin palautteen kerääminen.

Viitekehysten rakentamiseen käytettiin haastatteluista ja omasta prototyypistä kerättyä dataa. Viitekehys sisältää kaikki prototyypin luomiseen vaadittavat vaiheet. Viitekehystä luotaessa keskityttiin kustannustehokkuuteen.

Lopputuloksena viitekehys otettaisiin käyttöön seuraavassa siihen sopivassa projektissa. Viitekehystä voidaan myös muokata tarpeen mukaan projektikohtaisesti. Oma prototyyppi saatiin onnistuneesti kaikista kolmesta vaiheesta läpi ja on tällä hetkellä vapaasti ladattavissa. Toimeksiantaja voi myöhemmin päättää jatkaako prototyypin kehittämistä vai ei.

## ASIASANAT:

Prototyypin pakus, pelinkehitys, Unreal Engine 4, kustannustehokkuus

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## LIST OF ABBREVIATIONS (OR) SYMBOLS

2D	Two-dimensional
3D	Three-dimensional
B2B	Business to Business
CC	Creative commons
CEO	Chief executive officer
Cloud storage	Physical storage hosted on multiple servers and accessed through an application
Commissioning Customer	Morrow Games Ltd
CTO	Chief Technology officer
External testing	Testing done by a 3 <sup>rd</sup> party group e.g. publisher
Game play prototype	Core game play mechanics implemented in the prototype
GB	Gigabit, digital unit to measure data
GDD	Game design document
Graphical prototype	High quality graphics implemented in the prototype
IDGA	International Game Developer Association
Internal testing	Testing done by a group that includes the developers and their familiars
Ltd	Limited company
Market research	Organized effort to gather information about markets and customers
Pipeline	Set of tools used in a certain process
SFX	Sound effect
Subject 54	Title of the prototype created for this thesis

Steam	Virtual publishing platform for games
Texturing	Use of 2D images to create surfaces for 3D-objects
VR	Virtual reality

# 1 INTRODUCTION

The client of this thesis Morrow Games Ltd had a need for a framework that would enable them to validate projects in reasonable time and cost efficiently. A successful framework would then be used as a reference in the client's future game projects.

Using the framework would improve the efficiency of the game prototype design and development and also to figure out the most efficient and valid testing method for the prototype thereby improving the whole process and bringing down the combined costs for design, development and testing.

Morrow Games Ltd is a game development company based in Turku and has been active in game development since 2015. To this date Morrow Games Ltd has published three game demos and one full game. Currently Morrow Games is focusing on creating VR games and content.

In the theoretical section of the thesis the base principles for general prototyping and game prototyping were introduced. The main differences between them were investigated and the reasons why they differ were also taken into account. The traditional waterfall and agile design process models were also introduced in this section along with the basics of game design documentation.

Local game entrepreneurs were interviewed to investigate how they organize prototyping and how their prototyping principles differ from each other. During the interviews the selected companies also chose a single project to reflect their prototyping principles in practical use. The interviews included a general introduction to the interviewee and the company.

The practical section of thesis consists of two parts, the development of the Subject 54 prototype and compiling the prototyping framework. When going through the development phases of the Subject 54 prototype the thesis concentrates on the same topics as the interviews. The requirements for the prototype were that the development prototype had to be done by a single developer. The used development tools were defined by the commissioning customer.

When compiling the prototyping framework the data collected from the interviews and Subject 54 prototype will be taken into consideration. The framework was



designed to work as a skeleton that could be modified to fit the requirements of the prototype.

The conclusion chapter summarizes the successfulness of the project and what issues were confronted during the project. The chapter reflects on the on the fact that how the development of the prototype and the framework benefits the commissioning customer.

## 2 PROTOTYPING

### 2.1 Prototyping in general

The purpose of prototyping is to evaluate a design of the product by allowing users to actually test it. Prototyping allows the users to experience the product and enables them to deliver far more accurate feedback for the project opposed to base interpretations and speculation on the design documentation alone. (Software prototyping 2017.)

Generally prototyping involves four steps. First phase is to determine the basic framework for the design for example a simple game mechanic. Next step is to create a prototype that revolves around the basics and incorporates only minimal features to make the product usable. After users have tested the prototype you need to review the feedback for potential risk factors. When the feedback has been reviewed it is time to determine if the product is viable for further development. (Software prototyping 2017.)

As a development process the prototyping favors the agile model over the more traditional waterfall model. In agile development process the iterations are shorter and they make it possible to identify risk factors in early development phase. When the iterations are shorter customers can have more impact on the development itself. The waterfall model is a more forward moving process. After finishing a phase in the waterfall model the whole project moves forward. In the waterfall model the major risk factors might be identified in the very end of the project and this does not support the prototyping idea at all. (Vilmunen 2015.)

### 2.2 Game prototyping

Creating documentation is usually the first step in every project and in this case game projects are no different. Game Design Documentation (GDD) has no standard format. A successful documentation presents the vision of the game idea in sufficient detail and effectively. Generally gaming companies do not share their Game Design Documentation since this way they can protect their intellectual property rights and hide all the downfalls during the development. (Rouse 2005.)

The main difference between game prototyping and prototyping in general is the fact games usually are not designed to solve a problem. Usually when a prototype fails to deliver an answer to the problem a second prototype will be designed to solve the same problem. But when it comes to game prototyping, a failed prototype does not mean that the next prototype would be in anyway similar as the failed one. (Tulleken 2014.)

Generally game prototyping follows the same list of principles. First step is to create a extremely simple version that does not include any flashy graphics or sounds also known as game play prototype. After that you start to implement more complex game play elements. Every step should be tested and feedback collected. Even when you are working alone be critical about your work and try to figure what is crucial next step for the prototype. (Tulleken 2014.)

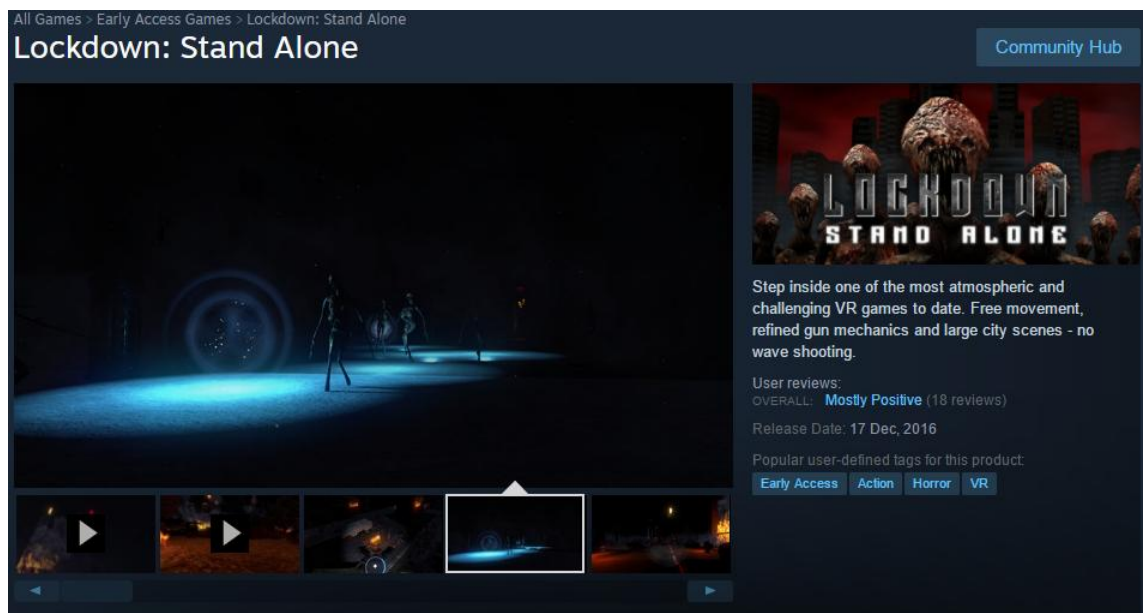
Paper prototyping is often ignored even though paper prototyping is easy and fast to create. Paper prototyping does not require high technical or artistic skills and almost anyone can create or participate in this low threshold process. You can paper prototype numerous different things like the maps, weapons or whole game play loops. Paper prototyping enforces the iterative design and fast decision making which is crucial when developing a game prototype. (Gibson 2014.)

Game prototypes are not perfect or visually impressive. Game prototypes are the minimum viable products of the game. The reason why you want to keep the prototype simple as possible is that you might need to pivot with you initial idea. If you are planning to create a 3<sup>rd</sup> person shooter game and during the development you run into some issues with the camera angles, you can rapidly change your idea without losing tons of work when you have done the prototyping correctly. (Llopis 2010.)

## 3 INTERVIEWS

### 3.1 Viversion

The interviewee CEO of Viversion Ltd Anton Korhonen has been programming ever since he was 12 years old. He has been mainly using C programming language. He founded Viversion in October 2016 with Teemu Malinen from Sifu Ventures Ltd. Viversion's main focus is in virtual reality game development for pc platform and Viversion has also create developer tools for Unity game engine.



Picture 1 Lockdown: Stand Alone Steam page (Viversion 2016.)

Viversion has published one full game in Steam and one developer tool for Unity platform. Viversion currently has four employees.

#### 3.1.1 Prototyping in general

Viversion's prototypes are based on one main feature or an idea. They use approximately 2 weeks to create the game play prototype. After the game play prototype Viversion revisits the game play prototype in one to three iterations to

implement graphical content. In prototyping Viversion always uses placeholder graphics to bring down the development costs.

After the prototype has gone through all the iterations Viversion decides if the prototype is viable for further development. Iterations will go through internal testing in which the developers will validate the successfulness of the iteration by gut feeling and If the project does not feel right for the developers Viversion will cancel the project.

Viversion handles the testing of the prototypes by using familiars. They acknowledge the fact that using a smaller testing group will give them less feedback but they also emphasize that this way they will keep their projects hidden from the public to be copied.

Viversion has cancelled five projects during the prototyping phase according to the feedback collected from internal testing. In the future Viversion sees a need for a longer prototyping phases with larger test groups to validate projects.

Viversion is using the same development tools for building prototypes and actual products.

List of tools that Viversion has used in prototyping:

Management, communication & design

- Trello & Slack

Development

- Unity, 3DS Max, Blender, Substance Painter, Photoshop, Audacity, Goldwave & Audition

Testing

- Internal testing & familiars

### 3.1.2 Lockdown: Stand alone

Lockdown: Stand Alone was published in Steam in December 2016. Viversion built a prototype from Lockdown: Stand Alone which went through three iterations until it was good enough for the developers to fully commit for the project.

For testing the Lockdown: Stand Alone Viversion used internal testing and familiars to collect feedback. As the prototype developed further Viversion had to scale down the project to reduce the development costs. Total time spent in prototyping was approximately two weeks. (Korhonen 2017.)

## 3.2 Rockodile Games

Joni Kuusisto has been working with Rockodile Games for four years as a CEO. His tasks consist of running the business and everyday tasks appointed for the CEO including paperwork and representing the company.

For four years Rockodile Games has been creating games for various platforms. They have published five games from which four are for mobile- and one is for pc platform. Currently Rockodile Games is focusing on more action oriented games for pc platform.

Rockodile Games is working in collaboration with Remote Control Production which provides Rockodile Games with consulting and other B2B services like testing.

### 3.2.1 Prototyping in general

Game prototypes are based on the documentation which is created when someone comes up with an idea. Depends on the scale of the idea whether the whole development team takes part in the design phase. Usually the person who came up with the idea compiles the documentation.

After creating the design documentation the development team itself validates the idea and the documentation before moving forward. Next step for the development team is to create the game play prototype of the project. This prototype is developed using free placeholders and it has the main game play mechanics implemented.

After completing the game play prototype it is validated by internal testing before it is sent to Remote Control Production for additional testing. This cycle will continue until all relevant mechanics are working.

The next iteration either happens after or before the game play prototype. The reason for this is the possible usage of the services of a publisher. If the development team wants to approach a publisher with the project then it is crucial to present almost finalized graphics since most of the time publishers want to see visually impressive prototypes. In this iteration only the most necessary game play mechanics are present and the level of graphical quality is extremely high. This version also goes through the internal testing and is then sent to Remote Control Production for extra validation and testing before it is sent to a publisher.

Generally the game play prototype is done first. The visually impressive version is relevant after the mechanics have been confirmed to be working. In some cases the publisher or marketing team will be contacted when there is only a design documentation to be shown for them. Sometimes the publisher insists on having finalized graphical quality in the very beginning of prototyping.

If the project incorporates a publisher then the prototype is only shown publicly at IGDA (International Game Developers Association) meetings so that the publisher has a clean slate for promoting the project. These prototypes are also tested by Remote Control Production for quality assurance and testing.

List of tools that Rockodile Games has used in prototyping:

Management, communication & design

- Slack, WhatsApp, Skype, Discord, SourceTree, Google Drive

Development

- Unreal Engine, Photoshop, Blender, Substance Painter, ZBrush, 3DCoat, Audacity, Visual Studio, Illustrator, After Effects, OBS Video.

Testing

- Internal testing, familiars, Remote Control Productions

Rockodile Games has built total of nine prototypes that have been through at least the first iteration. Generally it takes about six weeks to complete the prototyping process from a team of five and they use exactly the same tools to develop the prototypes and actual products.

### 3.2.2 Hear No Evil

Rockodile Games wanted to create an action genre game that later on was specified to be a twin stick shooter. Prototyping of Hear No Evil started with compiling the game design documentation. Before building the game play prototype the game design documentation was sent to Germany to be reviewed by the marketing team.

After the marketing team validated the documentation the team built the game play prototype in two weeks. This prototype had the main game play mechanics working with placeholder assets. This version was tested by the development team itself and by Remote Control Productions.

The development team spent the next four weeks improving the prototypes graphical quality. After the graphical quality level reached almost the final level the prototype was sent again to the Remote Control Production to be tested.

Rockodile Game spent a combined time of six weeks with the prototype and now they are looking for a publisher. (Kuusisto 2017.)

### 3.3 BitWeird Games

Miska Harjamäki is 27 years old graphical artist working for BitWeird game studio. Miska has been doing graphics for just under two years and he also has three years of programming experience.

BitWeird has been doing games for a little over a year now and they have published two mobile games, even though they do not exclusively develop games for mobile platform. Main focus for BitWeird is in game development but they don't exclude other projects. Currently BitWeird employs a development team of six.

Prototyping phase for BitWeird begins with an idea. Someone from their team comes up with an idea and then presents the idea for the rest of the team by pitching. If they



are successful in selling the idea for everyone then the next step is to address to the issues that the rest of team has brought up in the idea. If they can solve the problems in this phase the iteration is complete and they can move forward to the next iteration.

Next step is to create a paper prototype if it is possible. Paper prototype is the most cost efficient way to test simple game mechanics. Miska and BitWeird highly recommend using paper prototyping before developing the game play prototype in the game engine if it is possible. In some cases it is not possible to create the prototype on paper so BitWeird moves straight to the game play prototype in the game engine.

Both the paper and game play prototype are tested internally by the developers. When building the paper and simplified prototype BitWeird also does market research to identify possible competitors.

If the prototype passes the internal testing and is viable from the markets perspective BitWeird moves forward to the last iteration which includes creating placeholder assets for the prototype. This version of the prototype will be introduced to external testing. Depends on the project that is the external testing done by BitWeird using friends, family and other familiar entities or is the project sent to the publisher and they handle the testing completely. If the prototype has viable markets and has gone through internal testing and external testing they can make the decision that is the project viable for further development.

Generally the whole prototyping phase takes about one month including all three iterations. Most of the time that person who came up with the idea creates the paper and game play prototype by themselves. If the prototype does not pass the internal testing it can be cancelled during every step. BitWeird has used this method of prototyping to validate four projects. One of these projects has moved forward from the prototyping phase.

List of tools that BitWeird has used in prototyping:

Management, communication & design

- Trello, SourceTree, Hangouts, HacknPlan

Development

- Unity, Blender, 3DCoat, Substance Designer, Substance Painter, Quixel, Photoshop, Gimp, Clip Studio, Illustrator, Logic Pro

### Testing

- Internal testing, familiars & publisher

BitWeird uses mostly the same tools for developing the prototype and full version of the project. (Harjamäki 2017.)

### 3.4 Plush Pop Soft

Kasper Ekqvist is a student in Turku University of Applied Sciences and is specializing in game technology. He is currently 25 years old and has been studying the field for four years. Soon graduating Kasper has been programming for four years and is a co-founder of Plush Pop Soft. His tasks include managing and representing the team and also game design and programming.

The team of Plush Pop Soft has been together for almost 1.5 years and they have published two games. Their main focus is in mobile platforms but in the future they are possibly expanding to other platforms as well. Currently Plush Pop Soft employs four developers.

#### 3.4.1 Prototyping in general

Plush Pop Soft's prototypes are based on an idea. And from this idea they isolate the main game play mechanic and focus the prototype on that. The game play prototype is generally developed within a week to validate if the main game play mechanics are working. Then they validate the mechanics by having all the developers test the prototype. This concludes the first iteration.

In the second iteration Plush Pop Soft introduces placeholder assets to the prototype to have a better understanding of the game as a whole product. These placeholder assets include 3d-models and textures. Once again the prototype goes through the internal testing phase.

In the third and last iteration Plush Pop Soft implements sound effects and builds a prototype that can be tested externally in an organized event e.g. IDGA meetings or other community hosted events after it has gone through internal testing. This prototype includes somewhat polished mechanics and graphics.

Plush Pop Soft prefers to attend to these events and collect user feedback from there. In these events they usually meet more casual players and they can collect feedback when they are actually playing the game. Plush Pop Soft believes that when collecting feedback using strangers over friends, family and familiars gives more reliable data. This way personal feeling towards the developer won't affect the data.

Plush Pop Soft's develop the prototype for a week with all four developers working on it for all three iterations. All iterations include the internal testing but even though they don't completely agree on the prototype they still move forward to the next iteration. This way the developers give the prototype more time and possibilities to evolve in to a great game rather than cancelling it when first issues in the prototype show up.

List of tools that Plush Pop Soft has used in prototyping:

#### Management, communication & design

- Facebook Messenger, Skype, Slack, HacknPlan, Google Drive, Bitbucket, SourceTree

#### Development

- Unity, Blender, Photoshop, Illustrator, Visual Studio, Substance Painter, Clip Studio, GameSparks, Aseprite, Spriter Pro, Marmoset Hexels 2, FI Studio, Kontakt, Premiere

#### Testing

- Internal testing, familiars, community events

For Plush Pop Soft it feels natural to develop the prototype using exactly same the tools as they usually do. This way they don't have to change the tools and development environment when they advance from prototyping phase in to the major development phase.

### 3.4.2 Mini Golf Universe (Ekqvist 2017)

The idea for this game came from Plush Pop Soft's programmer and sound designer. They started to build the prototype based on the idea together. For a week they built the prototype and constantly collected feedback from rest of the team.

After one more week of developing they were ready to test it with friends, family and familiars. After collecting the feedback Plush Pop Soft quite quickly made the decision to move forward from prototyping phase to the actual development phase.

Mini Golf Universe is still development and Plush Pop Soft is planning to publish the game during 2017 summer.

### 3.5 Summary of the interviews

Company	Viversion	Rockodile Games	BitWeird	Plush Pop
Documentation	Yes	Yes	Yes	Yes
Iterations	3	2-4	2-3	2-3
Placeholders	Yes	Yes	No	Yes
Internal testing	Yes	Yes	Yes	Yes
External testing	No	Yes	No	No
Publisher	No	Yes	No	No
Time taken	2 weeks	6 weeks	4 weeks	1 week
Developers	2	5	3	4

Table 1 Company specific prototyping

The way that the interviewed companies conduct prototyping shows plenty of similarities between them. All of the companies have acknowledged the importance of documentation and have utilized the agile development process. All of them have indentified the critical phases in the prototyping process.

## 4 MORROW GAMES & SUBJECT 54 PROTOTYPE

This chapter goes through the default software pipeline used by Morrow Games in their game development processes. The pipeline has been defined by Morrow Games' CTO to ensure that all the software's used are compatible with each other. Tools selected to develop the Subject 54 prototype are picked by Morrow Games since it is crucial that their development tools are also taken into account when creating the framework.

### 4.1 Management, communication & design

These are tools used by Morrow Games for managing projects, communicating between the employees and designing the game projects.

Telegram is free instant messaging software that can be used simultaneously on multiple devices. Telegram supports sending messages, photos, videos and various types of files. Telegram focuses heavily on reliability and security. (Telegram 2017).

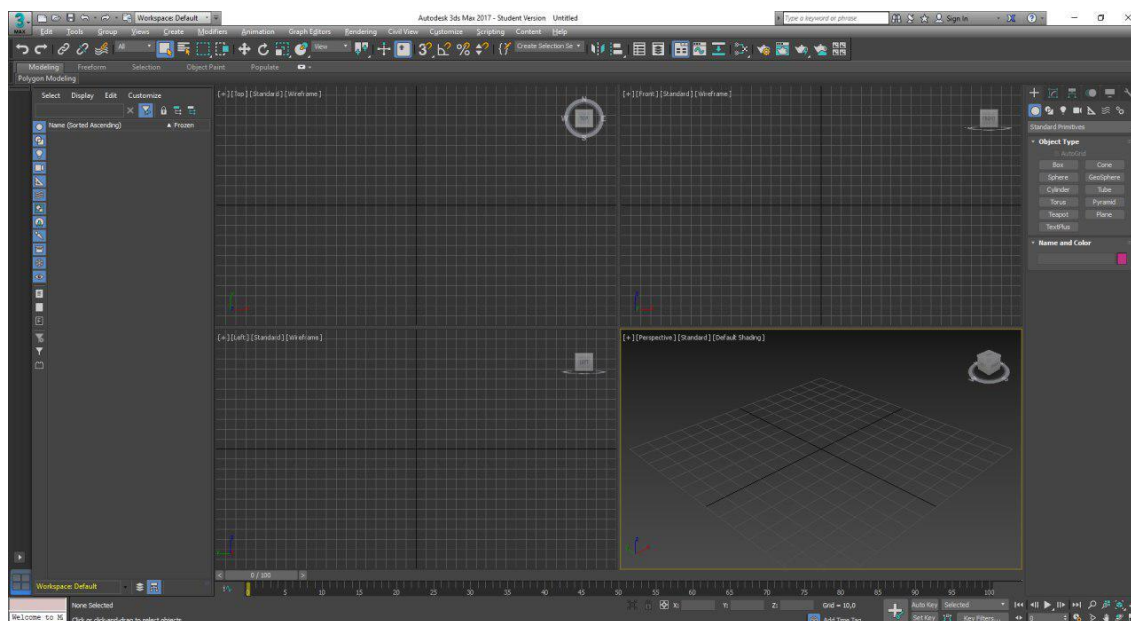
For small cloud storage space Morrow Games relies on Google Drive. Google Drive provides 15 GB of free cloud storage and documentation templates. The cloud storage is also accessible with mobile devices. (Google 2017.)

For designing and planning the projects Morrow Games uses the Game Design Document to refine the idea and make sure the concept is documented from the beginning. Morrow Games keeps the team updated by using Telegram instant messaging software for minor updates and weekly meetings for larger updates. All documentation and meeting agendas are always updated and available in Google Drive cloud service.

For the game design there were only few requirements set by Morrow Games. Firstly a Game Design Documentation (Appendix 1.) had to be made and the whole development phase had to be accomplished by a single developer.

## 4.2 Development tools

For creating simple 3D-models Morrow Games uses 3DS Max. With this software you can create e.g. 3D-models, animations and render images. Ubisoft Montreal also utilizes this software in their pipeline. (Autodesk 2017.)



Picture 2 3DS Max 2017 User Interface

For cloth simulation Morrow Games utilizes Marvelous Designer and characters are created by Adobe's Fuse software. Texturing the 3D-models is done by using software called Substance Painter.

As a game engine Morrow Games has chosen the Unreal Engine 4 developed by Epic Games. The game engine provides the most common tools and scripts used in game development by Morrow Games. Sound assets Morrow Games creates by using Audacity.

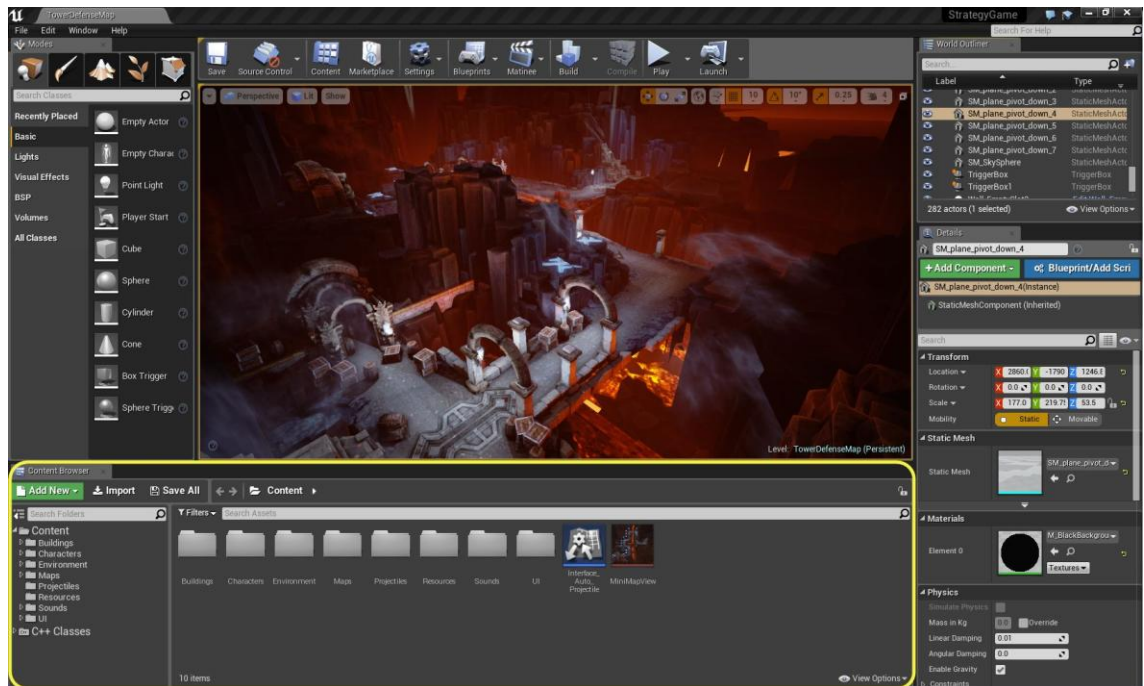
All the 3D content in Subject 54 was created by using software's provided by Morrow Games. Most of the 3D-models were created with 3DS Max. Marvelous Designer was used for more complex models like the pillows and sheets. Characters were created using Fuse. Completed 3D-models are exported as FBX-objects to the texturing software. All software's had the same exporting method.

The FBX formatted 3D-models are then textured by using Substance Painter. Substance Painter enables you to see the 3D-objects real time as the textures are applied to it. You can paint on both of the viewports and see the results instantly. You can export compatible files straight to the 3D-models source folder.

Textured models are then imported to the game engine which is in this case the Unreal Engine 4. When importing textures made with Substance Painter Unreal Engine compiles the material automatically.



Picture 3 Textured 3D-models in the game engine

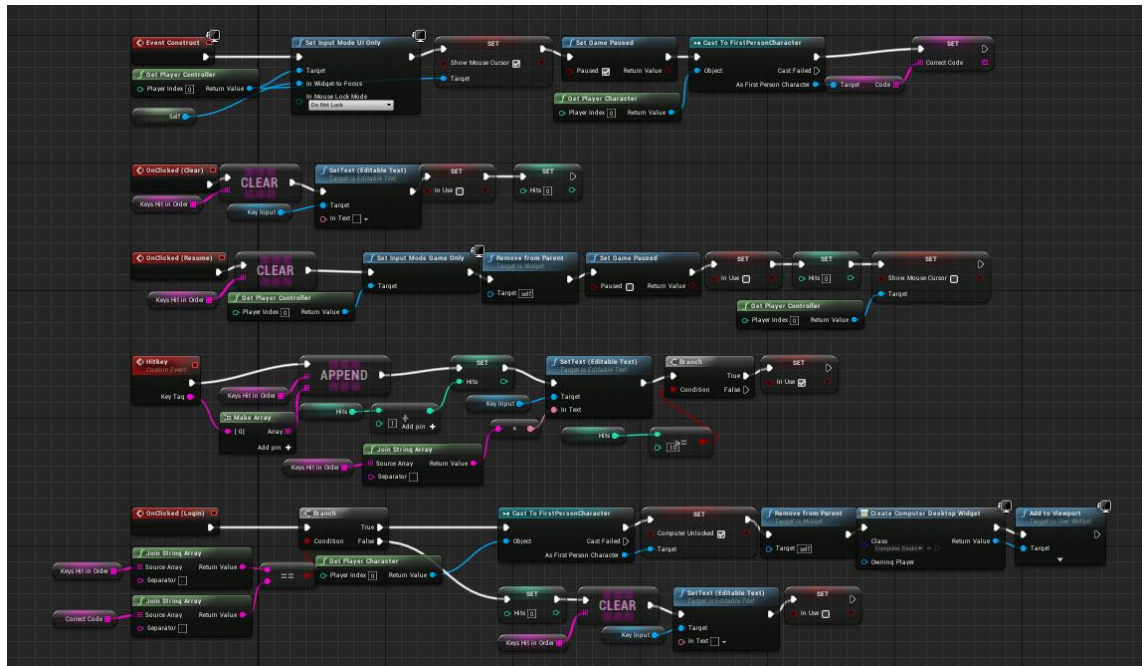


Picture 4 Unreal Engine 4 User Interface (Epic 2017.)

The highlighted content browser (Picture 4.) contains all the imported assets within the game engine. It is also possible to create custom folder structures to store assets. Folders created in the content browser are also created to the project folder.

Unreal Engine 4 has a built in node based blueprint system. Blueprints are created by connecting the nodes, events, functions or variables with wires the game engine automatically informs the user if incompatible nodes are being connected. The blueprints make it possible to develop game prototypes without writing a single line of code. Custom blueprints can be created with C++. (Epic 2017.)





Picture 5 Blueprints Visual Scripting in Unreal Engine 4

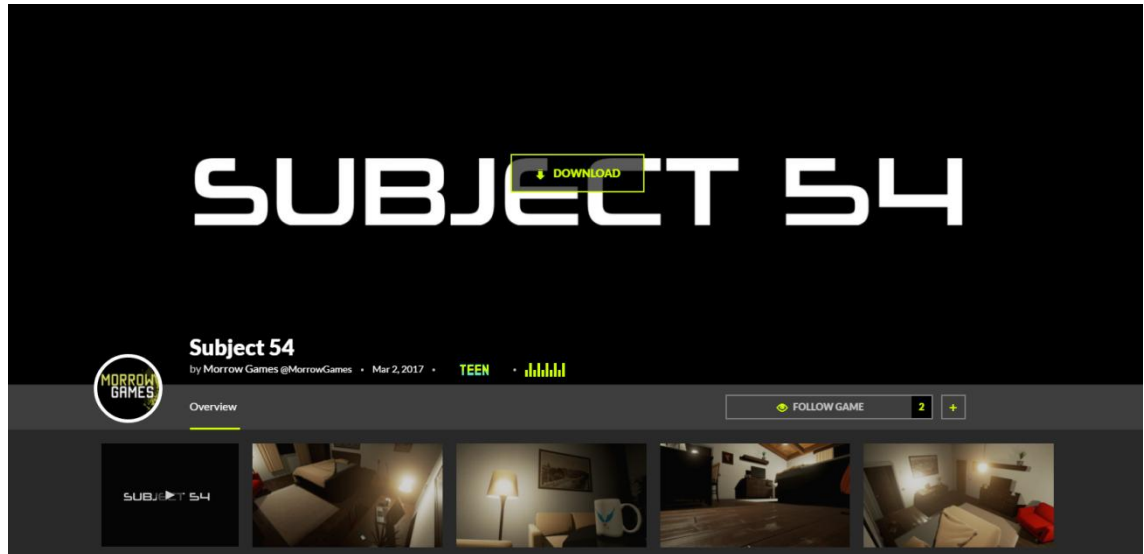
Sound effects were created by using Audacity. Source sound files were either created with the software or by recording sounds. Also 3<sup>rd</sup> party sound sounds assets with CC (Creative Commons) license were used.

#### 4.3 Testing

Generally Morrow Games only organizes internal testing, but to improve their pipeline Morrow Games had defined that Subject 54 has to go through some sort of external testing. Internal testing group includes the colleagues within the company and familiars. Unwritten written feedback is the most common feedback collected from internal testing phases. Purpose of the internal testing is to identify major bugs and other common mistakes that have undetected by the developer.

Prototype of Subject 54 went through internal testing phase before it was launched to be publicly tested in gamejolt.com. During the internal testing phase the prototype was tested by colleagues, familiars and other developers from the Turku game development community in the Morrow Games' premises. Unwritten feedback was collected and documented right after a play session ended. Majority of the issues discovered during the testing were attended to and the prototype was ready to be publicly tested.

Gamejolt.com is a platform for indie developers to publish their prototypes and demos. Morrow Games had published a game demo previously to this platform, but this would be the first prototype publication.



Picture 6 Subject 54 Gamejolt.com landing page

The Subject 54 prototype was uploaded to the site and all the screenshots seen in landing page (Picture 6.) were taken by using the game engine itself.

## 5 FRAMEWORK

### 5.1 Data collection and instructions

The framework was built on the information collected from the general introduction to prototyping, interviews and Subject 54 prototyping project.

The framework has been divided in seven sections. When reading the framework, it is mean to be read from top to bottom. When landing in a box that says “Pivot or stop prototyping” it means that at this phase the development teams needs to refine the work in that certain iteration or stop the whole prototyping process. The framework will in end in the section seven where the development team does the last validation and receives confirmation if the prototype is viable for further developing.

The framework will refer to tools listed in the thesis. These tools are just a list of possible tools to be used in prototyping. When selecting the tools keep in mind that to produce cost-effective pipeline the chosen tools must suite the need and skills required by the project and development team.

It is not guaranteed that use of the framework will have expected results. Always consult your supervisor before implementing a new tool for your production pipeline. The framework is no guarantee to compatible with all projects because it is designed for the commissioning customer.

## 5.2 Cost-efficient prototyping framework

The first section (Figure 1.) of the framework focuses on making sure that the project is documented right from the beginning. After creating the documentation it is the development team's responsibility to validate the documentation before moving forward in the prototyping phase. The framework also reminds that when working with a 3<sup>rd</sup> party it is crucial to take their opinion into account when validating the documentation. The framework does not contain tools to validate the documentation. If the documentation does not pass the validation phase it is crucial for the development team to consider creating another project or modifying the documentation.

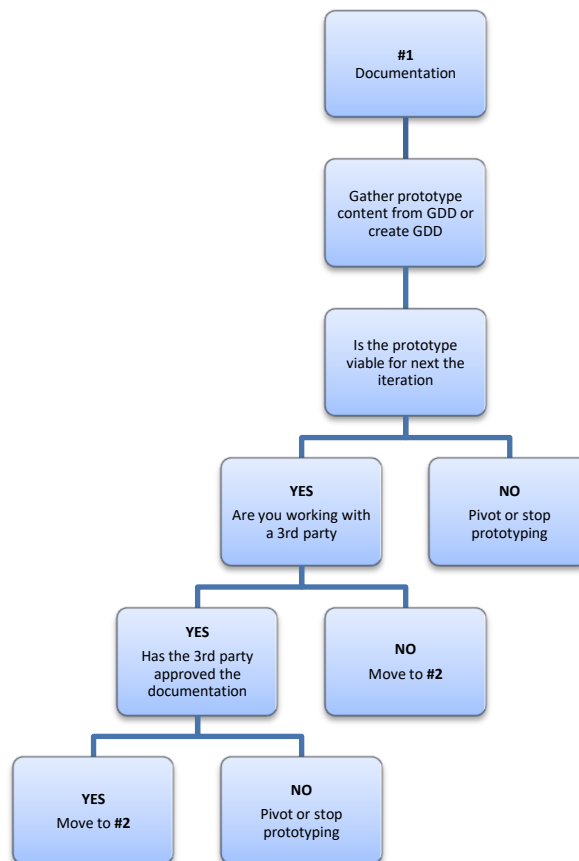


Figure 1 Framework section one

The second section (Figure 2.) is mostly meant for development teams that have not chosen or need to change their tools for project management and communication for some reason. If the development team has chosen those tools the framework will then ask them if they have chosen tools for development.

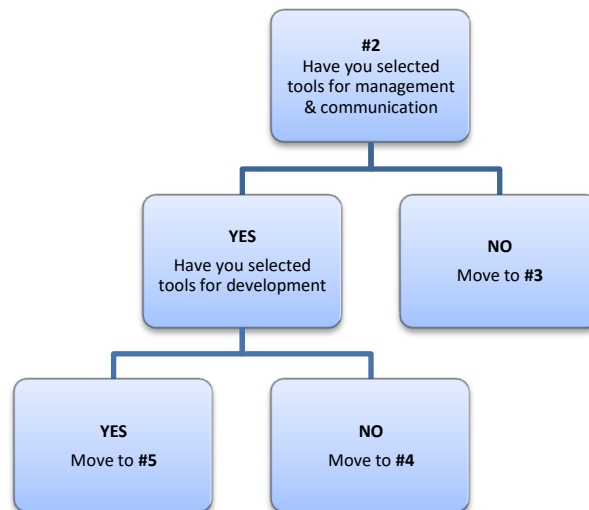


Figure 2 Framework section two

The framework user will be directed to this section (Figure 3.) only if they need to select tools for project management and communication. The framework refers to the list of possible tools to be used in project management and communication. The list is included in the next chapter of the thesis.

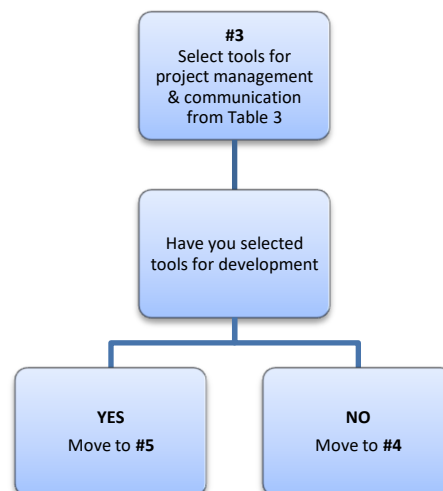


Figure 3 Framework section three

Section four (Figure 4.) is meant to ensure that the development team has selected tools for the development phase of the prototyping process. The framework refers to the list of possible tools to be used in game development. The list is included in the next chapter of the thesis. This section also confirms that is there a reason to prioritize on a graphical prototype over the game play prototype. For example if the development team has to send a visually impressive version to a publisher.

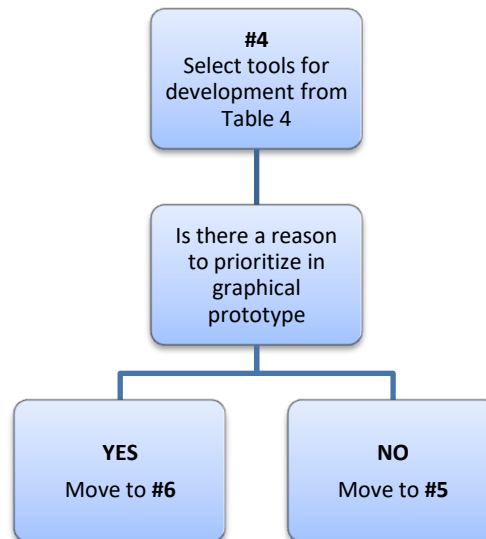


Figure 4 Framework section four

The fifth section (Figure 5.) focuses on creating the game play prototype which includes all the relevant game play mechanics documented in the game design documentation. The framework also suggests using placeholder assets to minimize the development costs. The framework also reminds that when working with a 3<sup>rd</sup> party it is crucial to take their opinion into account when validating the game play prototype. If the game play prototype does not pass the validation phase it is crucial for the development team to consider creating another project or modifying the game play prototype.

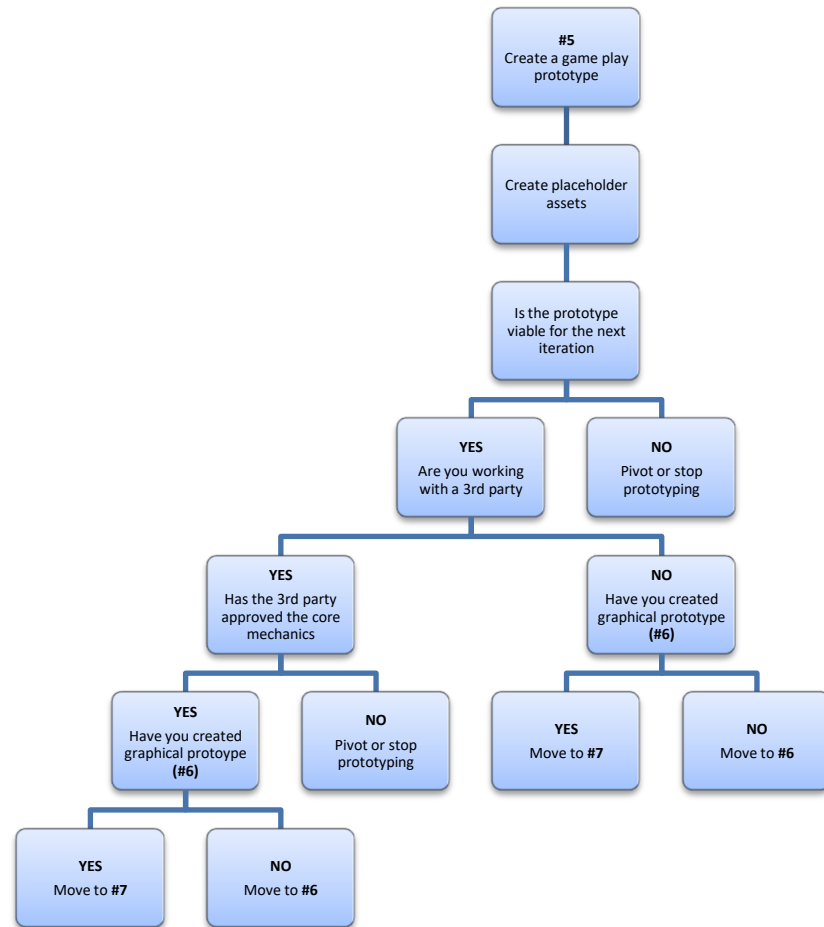


Figure 5 Framework section five

The sixth section (Figure 6.) is almost identical to the previous section the only difference is that the section focuses on creating the graphical prototype before the game play prototype. The framework also reminds that when working with a 3<sup>rd</sup> party it is crucial to take their opinion into account when validating the graphical prototype. If the graphical prototype does not pass the validation phase it is crucial for the development team to consider creating another project or modifying the graphical prototype.

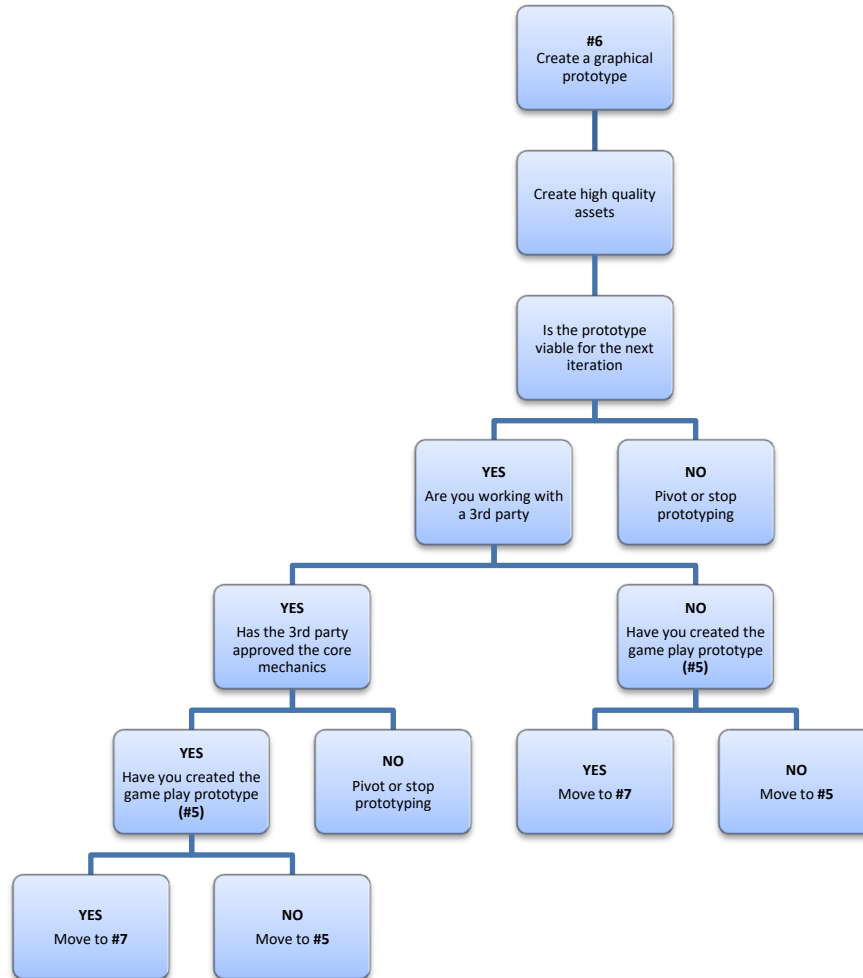


Figure 6 Framework section six

During the validation in the last section (Figure 7.) the whole prototype should be tested to see it is viable for further development. At this point the prototype should be able to provide sufficient feedback to make that crucial decision for the whole project. If the development team is working alone on the project it is up to them to figure out if the prototype is valid for further development or not. The framework also reminds that when working with a 3<sup>rd</sup> party it is crucial to take their opinion into account when validating the whole prototype.



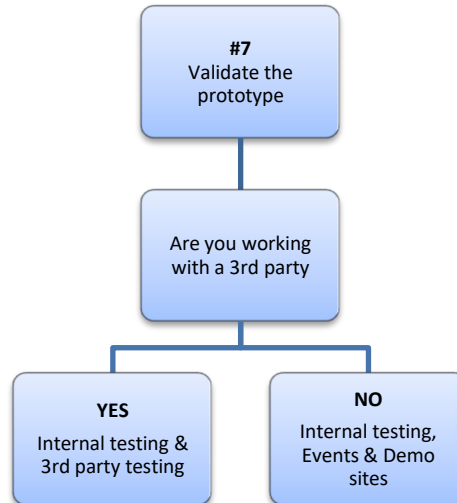


Figure 7 Framework section seven

Developing the prototype further without any validation negates the whole cost-efficiency of this framework. The main focus of this framework is to minimize the unnecessary development work by having the development team to validate the project after each prototyping phase. Only valid prototypes move forward in the framework and thus making it cost-efficient, since development of invalid prototypes is not endorsed in the framework.

## 6 RESULTS

### 6.1 Summary of prototyping projects

Project	Subject 54	Lockdown: Stand alone	Hear No Evil	Mini Golf Universe
Documentation	Yes	Yes	Yes	Yes
Iterations	3	3	3	2
Placeholders	No	Yes	Yes	No
Internal testing	Yes	Yes	Yes	Yes
External testing	Yes	No	Yes	No
Time taken	8 weeks	2 weeks	6 weeks	2 weeks
Developers	1	2	5	2

Table 2 Project specific prototyping

When excluding Morrow Games and BitWeird comparing the project specific results (Table 2.) to the previous company specific results (Table 1.) only little variation is shown. This indicates that the companies interviewed are faithful for their prototyping processes. Morrow Games didn't have any previous data about prototyping and BitWeird did not provide project specific information.

## 6.2 Prototyping tools

Tools discovered while collecting information about game prototyping from game developers in the interviews and the tools used in the development of the Subject 54 prototype.

Management	Communication	Version Control	Design
Trello	Slack	Bitbucket	GDD
HacknPlan	Telegram	SourceTree	Paper Prototype
Google Drive	WhatsApp		
	Skype		
	Discord		
	Hangouts		
	Facebook		

Table 3 Tools used in Management, communication, version control and design

Both the tools used in project management and communication (Table 3.) and in game development (Table 4.) have been chosen by the companies themselves by their own preferences. The lists do not cover all the possible tools used to complete these tasks.

Game engines	3d modeling	Texturing	2D	Sounds	Other
Unity	3DS Max	Substance Painter	Photoshop	Audacity	Visual Studio
Unreal Engine 4	Blender	Substance Designer	Illustrator	Goldwave	OBS Video
	ZBrush	Quixel	GIMP	Audition	After Effects
	3D-Coat		Clip Studio	Logic Pro	Premiere
	Fuse		Hexels 2	Kontakt	Gamesparks
	Marvelous Designer		Aseprite	FI Studio	
			Spriter Pro		

Table 4 Development tools used while prototyping

The testing groups can be divided into two segments, internal and external. In the internal testing the companies used their own developers and developers from the game development communities. In the internal testing the use of familiars was also common, the familiars consists of friend and family.

External testing includes the testing events that are organized by someone else than the developers themselves. Or if the prototype is sent or uploaded for a 3<sup>rd</sup> party to be tested for example a publisher.

### 6.3 Current situation of the prototypes

Lockdown: Stand alone is currently the only prototype that has been published as a full game. Hear No Evil and Mini Golf Universe have moved forward from the prototyping phase and are currently under development. Subject 54 is still available in Gamejolt.com for everyone. Morrow Games still haven't decided if they want to fully commit for the project.

## 7 CONCLUSION

The aim of the thesis was to develop a working game prototype and form a cost-effective game prototyping framework template for the commissioning customer.

Development of the Subject 54 prototype took about two months and it doesn't use any placeholder assets. The prototype features the main game play mechanics, finalized graphics and sound effects. Prototype went through 3 iterations. In the first iteration simplified game play mechanics were created based on the Game Design Document (Appendix 1). The second iteration had most of the graphics and sounds integrated to it and this version was introduced to internal testing. Last iteration was polishing the graphics and game play elements and fixing the bugs found during the internal testing phase. In the end of the last iteration prototype was published in Gamejolt.com to be tested by the public.

This whole process took approximately two and half months which includes the design of the prototype, development phase, internal testing, creating marketing materials and publishing it. There has been no indication yet that the commissioning customer is willing to develop the prototype further. Nevertheless the assets and scripts within the prototype are completely reusable with any other project.

The framework was designed to be used by Morrow Games in their current pipeline and thus it is not expected to work with other companies or pipelines in its current state. When utilizing the framework it is expected that the company replaces the suggested tools with tools from their own pipeline. The framework reaches its full potential when used in collaboration with the company's own pipeline. Morrow Games will utilize the framework in the suitable project.

The prototype and the framework met the requirements set in this thesis and the requirements set by the commissioning customer. As a learning process the development of the prototype gave an excellent overview of the whole game development process. Developing the game play mechanics was extremely time-consuming since I had no previous experience of programming. I was able to tackle all the problems confronted during the development by using the game engine manufactures documentation.

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## Subject 54 Game Design Document

### Summary

Protagonist has participated in pharmaceutical drug testing. He wakes up in a room and receives instructions to escape the room while under the influence of an experimental drug.

### Game play

Player has to solve puzzles in order to escape the room. Some of the events that occur during the experiment seem supernatural, but those are probably caused by the drug.

Puzzles are designed to be so hard that sometimes players need to rely on outside help for example Wikipedia or other sources.

Some of the puzzles are related to math and problem solving skills and some have references to popular movies or historical events.

### Mindset

Start of the game player should feel calm and adventurous. As the experiment goes on player experiences some supernatural events that should make the player feel discomfort. As the player gets out of the room he realizes that something has gone awfully wrong.

### Screens

Intro

Morrow Games logo

Subject 54 logo

Main menu

Background

Surveillance camera image from the room

Start



	Starts the game
Quit	
	Exit application
Pause menu	
Continue	
	Continue the game
Exit game	
	Goes back to main menu

### **Controls**

WASD to move

Mouse to look around

Point and press E to interact

### **Mechanics**

Player can interact with almost everything in the room.

Light switches, Television, Laptop, etc.

All events should have at least a function that the player declares “this is a television”. Preferably the player turns on the television.

### **Themes**

The room that the experiment takes place must be sort of clinical because it is property of a pharmaceutical company and its only purpose is to facilitate experiments.

The room should include objects that are required for puzzles and events. Minimalistic bedroom with a desk and television set. A bathroom can be in a separate room.

The room should feel like a normal bedroom.

## Game flow

Player reads a note on the wall next to the door

Player is referred as subject 54 in the letter. Letter also explains why player is there and what he must accomplish.

After reading the note player can explore the room freely

Room has two doors, one to the bathroom and the other one is the exit – both are locked

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In the bathroom there is a fluorescent text that is only visible in dark

Text is the password to unlock the laptop

This text should be random generated

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Player can turn on the laptop

Laptop takes while to boot

After boot to unlock the laptop player is required to give it a password

This password can be found in the bathroom wall

After giving the correct password player can access the desktop

From the desktop player find a puzzle icon which opens a puzzle screen

Puzzle is a 4x3 math problem where bottom line is circled with blue pencil

In the room there is also an oil painting of a bonfire

With the lighter player can set oil painting of fire

Behind the painting player will a 4x3 grid with 4 circles

These four circles indicate the correct answer for the puzzle

Combining the puzzles from the laptop player should have 4-digit code

---

In the corner of the room there is a cabinet with one locked door

Cabinet door is locked with a padlock

Key for cabinet can be found behind a painting

The painting falls to the floor when player has been in the bathroom once

In the cabinet player finds a safe with digital lock

Safe can be unlocked by using the code acquired from the laptop puzzle

From the safe player finds a note

Note has a picture of the Fibonacci spiral, the spiral has x mark in the middle and y where the spiral ends. Under the picture there is a footnote "Call me from x to y".

---

Next to the laptop on the desk is a mobile phone

Player can interact with the phone cannot reach any numbers

To unlock the door player must dial the correct number

Player can acquire the correct number from the safe in the cabinet

The correct number is 1123581321

By dialing the right number and calling to it unlocks the door

---

When player interacts with door matinee takes over

Door slides open

Player steps in to corridor

On the left of player there's staircase

Right in front of across the room is two doors

In the middle of the room there is sofa set

A body is lying on the table

Next to staircase is brick chimney

Next to the chimney there's a body lying on the floor

Player will be drawn to the staircase with and flickering light

Screen fades to black and demo ends

Credits

Back to main menu

### **Graphics**

Furnished bedroom

Furnished lobby

Furnished bathroom

### **Sounds**

All SFX for the interactive world

Main menu

Button sounds

TV SFX

Radio