Multiplier

Real-Time Tactics Unit Balancing Tool

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# Abstract

Game features need to demonstrate that they are able to improve things, such as gameplay, game experiences, and such, for a large percentage of players, or make the impossible possible for a smaller user base.[[1]](#footnote-1) We do not exactly know if adding an extra certain game feature can improve a game’s appeal overall. Game developers usually face this problem, and would ask themselves what features should their games include and what not to include. It is especially important when there is a possibility that adding a small game feature can make a big difference to make players notice or love their games.[[2]](#footnote-2)

The purpose of this paper is to evaluate whether adding a particular game feature is attractive and appealing to the players. This game feature, which is an editor built into a custom real-time strategy game, allows the players to customize the attributes of the game units. The evaluation is based on the players’ feedback on the game with or without the editor.

1 out of a total of 51 testers did not complete the survey after testing the game, and is therefore excluded from the evaluation. The rest of the testers were randomly assigned into 2 groups evenly, the Tool group and the Game group. Testers assigned to the Tool group were able to customize the game unit attributes via the editor and play, while the testers in the Game group only play the game.

The results from the groups show the version with the editor enabled is less appealing than the version with the editor disabled.

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# 1. Introduction

## 1.1. Terminology of Real-Time Abstract Strategy

“Real-time strategy,” is defined as a type of video game genre in which the game does not progress incrementally in turns, i.e., all actions are simultaneously executed.[[3]](#footnote-3) These games require the players to do real-time planning based on incomplete information of their surroundings and they need to handle resource management themselves.[[4]](#footnote-4) Resource management refers to the economics of the available resources the player has access to, and that includes but not limited to: unit resources, ammunition, raw natural resources, territories, and so on.

Abstract strategy games are games where the players think and decide on their moves, and pose minimal or no involvement in luck. Usually, the skill of the players would offset the luck element by a very large percentage of the time.[[5]](#footnote-5) The term mostly applies to board games, card games, and other tabletop games where luck is not the decisive factor. The word, “abstract” refers to games without having any themes, or have themes that are not important to the experience of playing, such as geometric patterns and shapes.[[6]](#footnote-6)

“Real-time abstract strategy” (RTAS) is a subgenre of abstract strategy games that are played in real-time, but this is disputed as a non-existing game genre from a game theory perspective.[[7]](#footnote-7) The nature of games where the actions are played out simultaneously is synonymous with “real-time”, therefore the term “real-time abstract strategy” may be defined as a subgenre of “abstract strategy”, mixed with elements of “real-time” gameplay. The company, Looney Labs, used this term to describe one of their games, *Icehouse*, as such[[8]](#footnote-8), and was the source of this dispute.

This paper will be borrowing the term, “real-time abstract strategy,” to define the custom-built software’s genre mentioned, regardless of its disputed status.

## 1.2. The Differences: Real-Time Strategy vs. Real-Time Tactics

Real-time strategy games are sometimes confused with real-time tactics (RTT), in terms of game mechanics and gameplay.[[9]](#footnote-9) However, they both carry the characteristics of real-time gameplay.

In real-time strategy games, players devise intricate strategies involving collections of resources, base-building, technology upgrades, and unit types to take advantage of what they believe their opponents will do, and what strategies their opponents will use, without any prior knowledge.[[10]](#footnote-10) Base building represents the dynamics of players securing the locations of abundant resources by base expansions. Unit building represents the limited selection of units are available to produce at any one time. Macromanagement represents the general economy aspects of managing the intake and expenses of the player’s resources, such as constructing buildings, conducting researches and technology upgrades, and the purchases of unique units and items affecting overall gameplay strategies.[[11]](#footnote-11)

These strategies usually involve applying upgrades which helps to make their units perform better than they would expect the performances of their opponents’ units, or playing mind games to deceptively lure their opponents to their downfall.[[12]](#footnote-12) As the game progresses, these player decisions will affect the overall outcome of the game. In other words, the master plan of all actions done will determine who wins the game.

Real-time tactics is a subgenre or a related genre of real-time strategy games, with the aspects of base building, unit building and the importance of macromanagement all removed from the game. Instead, it is about the placements of units on the battlefields, the unit troop formations, and the exploitation of terrain, the environment, and territory acquisition for tactical advantages against enemies. In short, it is all about how you win for each battle. Usually, players are provided with limited available resources, such as a given set of units provided in missions, and are tasked to complete game sessions using only those resources. Strategies to preserve limited resources, such as utilizing veterancy where units gain permanent bonuses when leveling up[[13]](#footnote-13), are therefore encouraged to increase the likelihood the player succeeds in completing the game session.

## 1.3. Origins of the Custom-Built Software and How It Ties in to RTAS, RTS, and RTT

Originally, the idea was to come up with a way to see if integrating mathematical equations into a real-time strategy game would work. Let’s say Xn is the increase of a unit upgraded from Level N to Level N+1.

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If Xn is a sine wave mapped to the Y axis from 0 to 1 on the X axis, what would happen? Will the game balance be disrupted? This main focus of this idea was about experimenting with game balancing using mathematical equations.

One proposed approach to working with mathematically tweakable game balance was to build a real-time strategy game with a tool allowing simple mathematical equations to determine usable unit's attributes, and assess the outcome. Note that this approach is not deemed to be the best approach of evaluating game balance through mathematical means. Nonetheless, if the results show that units with mathematically generated unit attributes can be used in a real-time strategy game and the game is deemed to be balanced to play after multiple counts of gameplay sessions, it may pave the way to future works in the realm of procedural content generation in real-time strategy unit balancing.

The custom-built software used a generic unit, represented as a simple, geometric shape, and increases in size as they level up as the game progresses (RTAS). All unit attributes, including permanent bonuses each unit will have as they level up (RTT), are completely customizable to the player beforehand (RTAS). This way, it incorporates unit building (RTS) and veterancy (RTT) into the gameplay. “Veterancy” is a word used to describe the effect of making units with more experiences, such as killing more enemy units or staying alive longer, more effective.[[14]](#footnote-14) This mixing of game elements means the game has multiple genres, but it is still a real-time strategy game since the game elements are either a subgenre or related family of real-time strategy.

## 1.4. Game Balance and Methods to Achieve Balance

Game balance is hard.[[15]](#footnote-15) It is a difficult task where the developers have to approximate the balance of game elements that function completely different from each other, and not to give any players more advantages over the rest. A major reason why game balancing is hard to achieve, is that the game can be difficult to perceive as being balanced.[[16]](#footnote-16) There is no clear, mathematical ways to come up with solutions to make the game balanced, and at the end, the developers would have to make an educated guess the best they can.

Real-time strategy games are notoriously known for their high difficulty when it comes to game balancing.[[17]](#footnote-17) Players can choose amongst various factions and units with different strengths and weaknesses, and the developers must carefully test all potential interactions and ensure they are balanced and fair across different types of terrain, maps, game modes, and scenarios. There is a particular interesting concept, called the “Nash equilibrium”, defined as “the existence of an equilibrium state where no players can benefit from changing their strategies.”[[18]](#footnote-18) This means the players will tend to gravitate towards the most optimum strategy, or the dominant strategy in an unbalanced game. The existence of such dominant strategy saps away the potential for choice, and in turn, making the game boring to play.[[19]](#footnote-19) Therefore, game developers strive to make their gameplay achieve the Nash equilibrium.

We look into methods of balancing games by having a couple of strategies for the players to choose upon, and allowing as minimal dominant strategies as possible, in order to minimize factors that may hinder the evaluations, and achieve Nash equilibrium. We also look into the option of allowing players to balance their units, to see if this increases the potential choices of strategies the players can choose from, so the players will not be bored by the game and lose the game’s appeal.

Games that have moderate dynamics and balancing may be used as references for designing our custom software. *Total War: Shogun 2*[[20]](#footnote-20), *Total War: Attila*[[21]](#footnote-21), and *Multiwinia*[[22]](#footnote-22) are all real-time strategy games where unit compositions are similar, and require the players to use strategic unit troop placements on the battlefield to win battles. In these games, the battlefield area is large enough to provide ample stimuli for players to venture out and prepare for battle.

Games with more complicated unit attributes and geographical properties that affect player decisions, such as be *Starcraft II*[[23]](#footnote-23), *Warcraft III*[[24]](#footnote-24), and *Total Annihilation*[[25]](#footnote-25), requires a more complex game balance. In these games, unit attributes are affected by dynamic properties of the units, such as speed, regeneration, and cooldowns, which are incrementally increased through researching tech upgrades. These bonuses added to the unit attributes were shown to determine the outcome of real-time strategy multiplayer game sessions[[26]](#footnote-26), and thusly, makes them attractive to the players and motivate them to obtain these upgrades.

Environmental obstacles used in these games, which can lead to players not being able to spot the enemies at a glance can also affect the outcome of the player game session. For example, trees with enemies behind it can block the player’s view from seeing the enemies. Other than environmental obstacles, the game, *Homeword: Deserts of Kharak*[[27]](#footnote-27), encourages the players to see further by advancing to higher ground, and to avoid lower ground near enemies to prevent hostile attacks. Players are given the option to use smoke screens to block the enemies’ line of sight, thus preventing them from receiving excessive fires when retreating from enemy units.

Similarly, some real-time strategy games, such as *Auralux*[[28]](#footnote-28) and *Footmen Wars*[[29]](#footnote-29), utilize map layouts that are designed symmetrically. *Auralux* provides the basis of linear upgrade paths that players can use during gameplay, as well as taking into account of the map layout. *Footmen Wars* provides a similar structure of gameplay, in which each units of different factions have attributes that players can upgrade accordingly, but ultimately, the players can only use that unit for the rest of the game. There has been research done on exploring map layouts and game balance in real-time strategy games, using *Planet Wars*, a game very similar to *Auralux* in terms of gameplay, as the basis of their research.[[30]](#footnote-30) What they have found is, as long as the map layout does not provide players more advantages over their opponents, it is considered to be a balanced map.

We can start to see many varieties of ways to approach to game balance in real-time strategy games, but most of all, unit interaction is one of many core components of real-time strategy games.[[31]](#footnote-31) Experimenting the possibilities of game balancing using mathematical equations in the realms of unit interactions, therefore, becomes the main focus of this research project.

## 1.5. Game Feature and Appeal

A game is defined as “a system of rules in which agents compete by making ambiguous decisions.”[[32]](#footnote-32) We group the system of rules to be a part of the game as features that the players can interact with. Thus, the game features become unique sets of system of rules that make up the game. When ambiguous decisions have meanings and repercussions within the game system, it has been said to cause new challenges to emerge, and will have an impact on the final outcome of the game.

The impact may be a certain type of experience the players may find attractive, or the players may perceive a liking for the experiences.[[33]](#footnote-33) This attraction is defined as the appeal to the game, or the perceived notion of the game’s appeal to the players. In short, by giving the ambiguous decisions of tweaking the game balance through the use of the unit attributes editor, we can then evaluate the editor, as a game feature, if it can increase the game appeal. Since game balance itself is a very debatable game design aspect in real-time strategy games, its meaning is therefore perceived to be very appealing, due to how ambiguous the decisions of approaches for tweaking the game are.

# 2. Game Design

## 2.1. Overview

In this section, the game players and the tool users are all described as end users, and “software” is used for referring to the tool and the game altogether.

The entire software is structured as a tool where the end users are able to interact with the editor and tweak the properties of the given 6 unit attributes used in the game. The editor allows the end users to define any possible leveling progressions, or power-ups, using mathematical equations. This also means the power-ups can be curved down into the negatives if the end users wished so.

A real-time strategy game is purposefully built in a way where game units are splitting and merging itself. The goal of the game is to wipe out the opponent’s units to win. The end users split their units to create more resources to merge. Merging units will upgrade their units to the next level, at the cost of a second unit of the same level prior to merging. As the end users continue to split and merge units, they will reach a state where neither player will win, or will win after a certainly long period of time.

With the editor and game, the end users are able to play a variety of game modes, which are Singleplayer, Multiplayer, and Simulation. All of these game modes are for the end users to test and tweak the unit attributes, so that the end users can verify if the game units are balanced enough. If balanced, the end users may choose to apply the mathematical equation to their own games as their heuristics for a balanced unit leveling progression.

## 2.2. History

The original premise of the software was a game designed around the possibility that complex unit interactions are defined using mathematical equations. Starting from very simple mathematical equations is a good starting point, so as not to be burden with how complex the mathematical representation was going to be, as well as the technical limitations to accomplish this. There were other considerations made while planning out the premise, even once suggested whether to venture forth into advanced generations of units whose interactions and relations are procedurally generated, but the scope of the game and the project itself forbid this.

When thinking about the composition of a real-time strategy game, it must contain a few elements that defines the genre: simultaneous gameplay, limited time to execute decisions, and the complexity of the game in terms of the large number of actions available per decision cycle.[[34]](#footnote-34) From a general point of view, defining elements are: resource management, base building, and enemy annihilation.[[35]](#footnote-35) Optional elements include stressing the importance of micromanagement and macromanagement, complicated unit interactions, and tactical strategies players can choose to put in practice. [[36]](#footnote-36) All of these elements mean, the final game would have to incorporate common elements, and use certain game mechanics to satisfy them.

The inspiration of having basic units be upgraded to stronger units of the same borrows from real-time tactics games, in the same veins as *Footmen Wars*[[37]](#footnote-37), where it is easier to reuse the same unit, but given stat boosts for upgrades.

To find the most simplistic math equation, the easiest solution constructed is to double up the number, or by doubling the result.

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Using the above equation, game units would be exactly twice more powerful when upgraded, and continues to be exactly twice as powerful for subsequent upgrades. It also makes designing a real-time strategy game easier to conceive, but harder to expand upon for flexibility. The next solution is to come up with some new math equations that are still simple to remember, but adds a bit of complexity to it overall. These equations are given as follows:

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It forced upon the idea that math equations should not be limited to just doubling up the results, and should use commonly known math operators to create complex results. And to support this, comes with a UI that handles these. The addition of the UI changed the software focus of being a game to a tool.

## 2.3. Game Mechanics

### 2.3.1. Attributes Editor

The editor feature consists of many UI components, creating an elaborate interface used for tweaking the numbers and values. This is done by having the end users provide a math equation, and then generate a series of results for each level, reaching up to Level 10. The end users can provide math equations by typing into the Equation Input Field. Using the Shunting Yard Algorithm[[38]](#footnote-38), the provided equation is then parsed and calculated to correctly print out the results.

Due to the many UI components possibly confusing the end users, toggleable tooltips have been applied everywhere to provide hints and tips on how to use them to the end users.

### 2.3.2. Splitting and Merging

The main game mechanics are game unit splitting and merging. Splitting is where the unit creates a duplicate of itself, and can sometimes be described as cell mitosis in biology. Merging is where a pair of units of the same level merges, creating 1 upgraded unit. The merging process can be described as cell fusion in biology. Splitting creates more units for the player to merge, starting from the most basic level (Level 1), and merging up to the highest level (Level 10).

Both of these unit abilities can be said as confusing to grasp, since they are not very common game mechanics used together within the game context. Depending on the given math equations that define the traits of the unit, or unit attributes, upgraded units may not be positively stronger as other units of different levels in comparison. For example, using Equation (3), it shows for every 2 merges (upgrades), the unit attributes increment once. This means, Level 2 units are the same as Level 1 units, but Level 3 units are stronger than Level 2 units.

### 2.3.3. Minimap

Inspired by the camera panning movement from WarCraft 3[[39]](#footnote-39), the camera moves in the X and Z axes when the end users start dragging within the boxed region, allowing it to move freely around on the map. This is added into the game to allow the end users to quickly see where the actions are occurring in the map level. This minimap also allows the end users to precisely command their units to move to a location where it would mostly be out of bounds in the main camera.

### 2.3.4. Autonomous Attacking

When enemy units are nearby, the end user’s units will go chase after them and attack the enemies once they are near enough. This helps to prevent the end user from solely focusing on micromanaging the game units, and to observe the unit interactions with the tweaked unit attributes.

### 2.3.5. Lack of Fog-of-War

This comes with a caveat as part of the software. Fog-of-war[[40]](#footnote-40), is known in the military, referring to the general friction of forces, which are danger, exertion, uncertainty, and chance, comprising the climate of war. In typical real-time strategy games, fog-of-war refers to the black fog covering the world in pitch dark unless revealed to the player when their units are nearby, simulating these general friction of forces. In other words, only the players can see objects within their line of sight. Players can only guess information retrieved from the glimpse of visible portions in the scene and plan out their strategies using known information. This software lacks the fog-of-war element, therefore the end users are expected to look at unit interactions and observed if their units are balanced. This is the caveat that differs from typical real-time strategy games, and may limit itself on how truly accurate it portrays a gameplay session.

### 2.3.6. A.I. Gameplay

This feature can easily be observed in Simulation Mode, and is playable in Singleplayer Mode. The game A.I. uses finite state machines, with each finite state machine carrying out a specific order based on the game A.I.’s status. Which units to carry out the commands, and where the units are to go to, are all determined randomly. The game A.I. also utilizes trick merges heavily, in which 2 units on the map very far apart from each other merges, creating an upgraded unit in the middle.

These features of gameplay are what makes up the entire software, allowing the end users to use or play them whichever they want.

## 2.4. How Unit Attributes Relate to Game Design

To explain, the 6 main unit attributes used in the software is applicable to most types of gameplay. They consist of elements from generic real-time strategy games to form correlations. Here are a few examples:

Health typically applies to unit health, health of a certain type of units, or it could be movable buildings. Attack would usually refer to how much damage the unit can deal to another unit, how much damage reduced caused by armor upgrades (by multiplying the attack reduction on the armor or attack stats upgrades, or multiplying the reciprocal of armor upgrades, attack-weakening buffs). Speed is often referred to as the speed of the unit’s movement, or traversal speed, or how light/heavy the units are. Attack Cooldown may refer to the short pause between each unit attack, the buffs of obtaining an item that reduces cooldown, or the intervals of boss attacks. Split may refer to the time the players has spent on in producing, gathering, and obtaining resources. Merge may refer to the time players has spent on tech upgrades, tier leveling, construction of resources, and so on.

There are many potential usages in which the 6 main unit attributes can apply to, and it doesn’t have to be very restrictive. Each of these potential usage is therefore related to game design, even though their representations may be different.

# 3. Resources

The main resources used is Unity game engine, where the project uses Unity Networking, or UNET for short. Bugs/glitches tends to pop up from time to time, but UNET is very reliable when it comes to internet connection stability. The Unity3D engine developers mentioned they will improve UNET further down the line as more fixes coming soon.

Other resources include the following:

* Unity3D Forums, the main where professionals, amateurs, students, and hobbyists come and enjoy discussions on various matters.
* Reddit, a place where it is mostly showing off concepts of ideas that the game, or me, can witness and discuss about.
* Freenode IRC, an online internet relay chat channel where users can chat with other developers working on other things and helping each other out.

# 4. Evaluation

This study only considers measuring the game appeal of a game version and a tool + game version. Therefore, it does not look at how the experiences of the user interface is received, how simple the game art is, how the game is designed, how useful the tool is, what uses the tool can be applied to, and so forth. Because game appeal is a very subjective concept of how likeness the players perceive when playing games, it is ill-advised to consider the result as an overall outlook for tools to appeal to gamers.

## 4.1. Research Method

There is a total of 51 participants involved in this experiment, split into 2 groups, the Tool group and the Game group. There are 25 participants in the Tool group, and 26 participants in the Game group. Only 1 participant from the Game group is left out due to invalid data.

This study uses 2 versions of the custom-built software. One version, which has the editor feature enabled, is given to the Tool group to play around with. The other version, which has the editor feature disabled completely, is given to the Game group. Once both groups have finished completing their session, they are then given a post-test survey. This survey contains 6 questions based on a 5-point Likert scale, and 14 qualitative questions, mainly for feedback purposes.

Having qualitative questions can be used to determine what improvements the custom-built software may need to minimalize affecting factors, while also making sure the participants are not randomly filling out the form.

## 4.2. Research Question

Appeal refers to how well-received the end users liked from using a software. Since the custom-built software has a tool with a game designed into it, the appeal therefore refers to the game appeal of the game experience enhanced by the use of the tool. Use of the custom-built software will allow us to compare if having a built-in editor has more game appeal than with just a game. This study does not consider anything else regardless of how well the software is designed, implemented, and/or polished.

## 4.3. Result

To explain, 3 is neutral, 1 is in disagreement, and 5 is in agreement. Anything above 3.0 is considered as positive agreement. Anything below 3.0 is considered as negative agreement. Analyzing the 6 5-point Likert-scaled questions into a data set gives the results, shown in the table below:

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| --- | --- | --- | --- | --- | --- | --- |
| **Mean (3)** | **Appeal** | **Learning Curve** | **Competition** | **Replay Value** | **Fun** | **Preference** |
| **Tool** | 3.56 | 3.24 | 3.84 | 3.36 | 3.88 | 3.6 |
| **Game** | 4 | 4.32 | 4.2 | 3.68 | 3.88 | 3.92 |

The results give the following observation:

* The game appeal for the Tool group is less than the Game group.
* The Tool group has more difficulty in understanding the software than the Game group.
* The Game group is more likely to play the software with another player than the Tool group.
* The Game group is more likely to play the software again than the Tool group.
* Both groups have equal amounts of entertainment value.
* The Game group prefers this type of software more than the Tool group.

# 5. Conclusion

In conclusion, having a tool built into the game is less appealing than having just the game itself. There are many possible factors that could contribute to this.

# 6. Future Work

Note that the custom-built game may be used to explore the premises of game balance using a mathematical approach, and not about whether procedural content generation game balance for real-time strategy games is possible. This paper does not explore these premises, and it would require further research for related future works.

## 6.1. Procedural Content Generation

There are video games that have done research in procedural content generation, in which some of them were able to use procedural content generation methods and techniques, but the usage is somewhat limited to a particular type of game content.[[41]](#footnote-41) It has also been proven that it is possible to have automated content generation in mainstream games.[[42]](#footnote-42) Notable examples include *Minecraft*[[43]](#footnote-43) and *Mini Metro*[[44]](#footnote-44), in which the former uses procedural content generation to generate terrain, and the latter uses procedural audio generation.

Procedural content generation in real-time strategy games is one of the most interesting challenges in the video game development process.[[45]](#footnote-45) The dynamics in real-time strategy games alone vary greatly, especially when involving multiple players of varying skill levels and backgrounds. These dynamics can be treated differently depending on how the contents are procedurally generated, therefore paving the way for many possible research routes, of which procedural map generation for a real-time strategy game has already been explored[[46]](#footnote-46).

There has been research done on production capability for different species of units in a game. Units that rely only on damage per second is not the best, but rather a mix of other unit attributes, such as hit points, defense points, along with other properties, is suggested.[[47]](#footnote-47) Other researches involve using procedural map generations built to fulfill requirements in order to maintain interesting and appealing games, suggesting that game balancing can be perfectly achieved only on extremely dull games.[[48]](#footnote-48) It also theorizes having moderate dynamics and moderate balancing can give ample stimuli to players to expand and to seek their enemies.

# 7. Postmortem

This section explains the woes and troubles the author has to go through, and shares his experiences to interested readers. It is written in first-person perspective.

## 7.1. What went right?

### 7.1.1. Choosing Unity

Before the end of summer, I had done my research on what game engine supports multiplayer natively. This means it is the responsibility of the engine developers to maintain network multiplayer support, as well as provide an easier way for developers using the game engine to use the network system. At the time, Unity and Unreal Engine had just been released for free for personal uses, but only Unity supported network multiplayer right from the beginning.

Knowing almost little to nothing in C# and Unity in general, I decided to embark on the journey of learning how to use Unity. Thinking back on this decision, I feel I have made the right choice in learning how to use a new game engine. It helps to have another set of skillset, in my opinion.

### 7.1.2. Scoping the Project

I know from the beginning that I only have less than 1 year to complete this Master’s project. This means I need to think of a project that will take about 1/3 of the year to complete, thanks to taking a course on Production Management for Interactive Media.

As it turns out, the entire scope of the project lasted exactly just 11 months, which is an awesome feat of accomplishment on predicting how long the project development will take. I would highly recommend readers to scope their projects down to 1/3 of the original total planned time. It really helps once you are close to the end of the development phase.

## 7.2. What went wrong?

### 7.2.1. Tutorial Manager

I've learned my lessons when it comes to creating a tutorial for my game. So I want others to not follow my footsteps when they are also working on, or are about to start working on the tutorials.

**What not to do #1 - Make 1 Tutorial Manager managing every single item, when they all can be broken down into modular components.**

What boils down to is, my game is never designed from bottom-up to be very modular. I haven't used Open-Closed Principle when I was making my game, so the whole game was built with "rewrite every scene from scratch for every additional modes". This also means, the tutorials cannot be made to allow players to issue commands or do their own thing, while the tutorial "guides" the players around. It's just not possible, unless I redid everything from scratch again.

Instead of doing a rewrite due to time constraints, I have to resort to static animations and force the players to read monotonic dialogues. That would not give a good game experience overall for the players in the long run.

**What not to do #2 - Write all dialogues inside your Tutorial Manager script.**

This is especially true if you want to have a tutorial that will be modified over and over again until it is right.

For me, since I have to create the game in Unity Web Player as a browser game, I didn't think much on what to do with this, and decided that I will be writing the dialogues up in a C# class object and make it easier to set and get. I was actually lucky that I do not have to work a lot on the tutorial dialogues. But thinking how hard it is to modify the dialogues, I think it would be best to put it in this short list.

**What not to do #3 - Completely separate animations, scripted dialogues, and scripted events.**

This is key. Like what I mentioned before, I have to do everything from scratch when I'm adding additional game modes to the game. And that includes the tutorial mode. Since all game objects are not built with modularity in mind, there is not much I can do except to "wing" it, and pretend to the players that I have something to show to them.

This means, I would have to find some way to manage tutorial animations, scripted dialogues, and other events that needs to occur for the players to understand what's going on. I managed to separate all three of them, and they work nicely, except for a few major flaws.

* You cannot rewind the tutorials.
* You need to restart the tutorials from the very beginning in order to get to a certain point the players missed out on.
* You have to exit the tutorials first.
* You cannot easily move anything around. If you have a script that needs to be moved earlier, everything needs to be rewritten.
* It is hard to get the timings right.
* You cannot change the length, the width, and the height of dialogues.
* It is definitely hard to track down weird bugs that would work normally in some cases, but not other cases.
* It is painful to fix when you are dealing with free aspect ratios. Good thing you can give fixed aspect ratios on some websites.
* You are limited to publishing on those websites.
* You are limited in any other ways.
* You are limited to a certain Unity game engine (because I'm using Unity Web Player).

Yes, the last one is really harsh on my development. Because every significant component of a good tutorial is effectively affected poorly.

With just the tutorials alone, I have my internal testers complaining very much on the flaws of the tutorials to the point they do not want to read a few **paragraphs**. Yes, I said paragraphs, because I cannot modify the dialogues. I can do something with the UI, but the dialogues are not affected by that in any way.

Still, this last bit is crucial to me. I do not have any ideas on how to create **interactive** scripted tutorials. So I had no other options but to make the tutorials I am using right now. In the future, I’ll first do a bit of research on how to make interactive scripted tutorials when the time comes for me to make a tutorial, then try to build a foundation for making game objects more modular for use with tutorials and the game.

### 7.2.2. Multiplayer and “New Multiplayer”

There was a point where I have just finished Multiplayer mode for the project. It was working fine, but bugs are much more frequently appearing, and it is really hard to get the client have the same variable values from the server sometimes. It was getting annoying to the point that I decided to redo Multiplayer mode from scratch, 3 weeks late than I thought I would start doing.

In hindsight, when I noticed there is trouble with syncing variable values, I knew that was the moment where I need to rewrite the codebase. But the pressing feeling of “Oh, I can go ahead and fix this. No worries,” is actually the driving force for delaying the rewrite. It is the train of thought that I have yet to overcome when fixing a feature that was already complete and working.

In the end, the rewrite was completed, and now I am much happier with how it turned out. Variables sync more reliably from the server to client and vice versa, and the issues of desynchronizations have decreases a lot. It is still there as of writing, but it is much easier than what was before.

Always rewrite from scratch if you think something underlying the mess of code is wrong.

## 7.3 What did I learn?

### 7.3.1. Things do not always go the way you wanted them to go

During the course of development in Unity, there are multiple times where the Unity would not cooperate with me. For example, having multiple [SyncVar] variables placed onto a game object, and Unity will sometimes set values incorrectly, even though they are supposed to sync the variable values across the network. When this happens, I would have trouble tracking down why it is not working the way I wanted them to be. It takes a lot of time debugging and asking questions on the forums, and you will sometimes get answers every other day.

Or how about the time when the function does work, but it turns out there was an upper limit on the number of usages you are allowed to make. Many developers complained of this, and subsequently the Unity3D developers had to make some compromises to get the functionalities to work. The wait for the updates lingers longer than anticipated sometimes.

Game engines developed by other organizations, such as Unity3D, means those game engines are hard for other developers who use them to fix when they come across issues with the engines.[[49]](#footnote-49) And they would choose to make their own engine so they can have total control over every aspect for their games. I did not go through this, because I know the feature that I wanted to use, which is the network multiplayer capabilities, is really tough for a sole developer to work on, let alone completing the entire project as a whole. It is just not possible, and for that, I learned that it is a good compromise for me to use an existing game engine than to develop a game engine from scratch, and facing the troubles of the engines not working with you is a hurdle this compromise brings along.

Accepting this fact is easier, I feel.

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# 9. Appendices

The first appendix should be the IRB questionnaires handed to the testers/volunteers. This is important. Can be split up into multiple appendices in case 1 section is not enough.

Any other following sections can have anything I want that is related to this whole project, even if it is irrelevant but useful resources. This includes project documents, documentation and API manuals, game art, conceptual designs, irrelevant sketches, notes, scrawls, etc.

Proposals can also be added into the appendices, but it must be marked as old, new, or anything in between. (Uncertain if that is the case.)

Nothing stops me from adding nothing, though.

1. (Pennington, 2003) [↑](#footnote-ref-1)
2. (Nutt, 2014) [↑](#footnote-ref-2)
3. (Xiong & Iida, 2014) [↑](#footnote-ref-3)
4. (Cheng & Thawonmas, 2004) [↑](#footnote-ref-4)
5. (International Abstract Games Organization, 2010) [↑](#footnote-ref-5)
6. (Thompson, 2000) [↑](#footnote-ref-6)
7. (Hale-Evans, 2007) [↑](#footnote-ref-7)
8. (Looney Labs, 2016) [↑](#footnote-ref-8)
9. (Walker, 2004) [↑](#footnote-ref-9)
10. (Kleinberg, 2011) [↑](#footnote-ref-10)
11. (Giant Bomb, 2016). Macromanagement is derived from micromanagement in real-time strategy games. [↑](#footnote-ref-11)
12. (Lahiri, 2010) [↑](#footnote-ref-12)
13. (YurdleTheTurtle, 2010) [↑](#footnote-ref-13)
14. (Wikia, 2014), (Wikia, 2016), and (OpenRA, 2016) [↑](#footnote-ref-14)
15. (Burgun, Understanding Balance in Video Games, 2011) [↑](#footnote-ref-15)
16. (Burgun, Understanding Balance in Video Games, 2011) [↑](#footnote-ref-16)
17. (Egenfeldt-Nielsen, Smith, & Tosca, 2012) [↑](#footnote-ref-17)
18. (Nash, 1950) [↑](#footnote-ref-18)
19. (Egenfeldt-Nielsen, Smith, & Tosca, 2012) [↑](#footnote-ref-19)
20. (Onyett, Total War: Shogun 2 Review, 2011) [↑](#footnote-ref-20)
21. (Hafer, 2015) [↑](#footnote-ref-21)
22. (Griliopoulos, 2008) [↑](#footnote-ref-22)
23. (Blizzard Entertainment, 2015) [↑](#footnote-ref-23)
24. (Blizzard Entertainment, 2002) [↑](#footnote-ref-24)
25. (Dulin, 1997) [↑](#footnote-ref-25)
26. (Bangay & Makin, 2013) [↑](#footnote-ref-26)
27. (Blackbird Interactive, 2016) [↑](#footnote-ref-27)
28. A minimalistic real-time strategy game for Android, based in outer space. (Parker, 2013) [↑](#footnote-ref-28)
29. A real-time tactics custom map game for the real-time strategy game, *WarCraft III* and its expansion, *WarCraft III: The Frozen Throne*. (StrategyWiki, 2014) [↑](#footnote-ref-29)
30. (Lara-Cabrera, Cotta, & Fernández-Leiva, A Procedural Balanced Map Generator with Self-adaptive Complexity for the Real-Time Strategy Game Planet Wars, 2013) [↑](#footnote-ref-30)
31. Unit interaction is discussed in the Introduction of (Li Yan, 2014). [↑](#footnote-ref-31)
32. (Burgun, What Makes a Game?, 2012) [↑](#footnote-ref-32)
33. Perceiving a liking to a game feature is done by justifying the choice to obtain a higher level of entertainment. See (Slovic, 1995) in regards to choices and the prominence effect. [↑](#footnote-ref-33)
34. (Ontañón, et al., 2013) [↑](#footnote-ref-34)
35. These gameplay elements are observed from the many samples of real-time strategy games that are referenced. Note that not every real-time strategy game fits these criteria, but at least the majority of games do. [↑](#footnote-ref-35)
36. Most real-time strategy games come with campaign modes, which utilizes these optional elements. However, depending on the gameplay experienced in multiplayer skirmishes, these elements may not appear dominantly. [↑](#footnote-ref-36)
37. (StrategyWiki, 2014) [↑](#footnote-ref-37)
38. (Dijkstra, 1961) [↑](#footnote-ref-38)
39. (Blizzard Entertainment, 2002) [↑](#footnote-ref-39)
40. (Shepherd III, 1997). This paper also goes on to define what the term, “fog of war,” is about. [↑](#footnote-ref-40)
41. (Mark Hendrikx, 2013) [↑](#footnote-ref-41)
42. (Hastings, Guha, Member, IEEE, & Stanley, 2009) [↑](#footnote-ref-42)
43. (Gallegos, 2011) [↑](#footnote-ref-43)
44. (Dinosaur Polo Club, 2015) [↑](#footnote-ref-44)
45. (Lara-Cabrera, Nogueira-Collazo, Cotta, & Fernández-Leiva, 2015) [↑](#footnote-ref-45)
46. (Lara-Cabrera, Cotta, & Fern´andez-Leiva, 2012) [↑](#footnote-ref-46)
47. (Fayard, 2007) [↑](#footnote-ref-47)
48. (Lara-Cabrera, Cotta, & Fernández-Leiva, On balance and dynamism in procedural content generation with self-adaptive evolutionary algorithms, 2014) [↑](#footnote-ref-48)
49. (StackExchange, 2016) [↑](#footnote-ref-49)