Multiplier

Real-Time Strategy Unit Balancing Tool

By Thompson Lee

A Project Submitted to the Faculty of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirement for the

Degree of Master of Science

in

Interactive Media & Game Development

May 2016

Advisor: Professor Dean O’Donnell

Reader: Professor Brian Moriarty

Reader: Professor Charles Rich

Table of Contents

[**No table of figures entries found.** 3](#_Toc446780851)

[Abstract 4](#_Toc446780852)

[Acknowledgements 5](#_Toc446780853)

[Introduction 6](#_Toc446780854)

[Strategy vs. Tactics 6](#_Toc446780855)

[Inspiration 6](#_Toc446780856)

[Procedural Content Generation 7](#_Toc446780857)

[Game Balance and Related Works 7](#_Toc446780858)

[Related Works 10](#_Toc446780859)

[Game Design 11](#_Toc446780860)

[Overview 11](#_Toc446780861)

[Game Mechanics 11](#_Toc446780862)

[Other Things Worth Mentioning 11](#_Toc446780863)

[Resources 12](#_Toc446780864)

[Tools 13](#_Toc446780865)

[Evaluation 14](#_Toc446780866)

[Research Method 14](#_Toc446780867)

[Research Question 14](#_Toc446780868)

[Result / Conclusion 14](#_Toc446780869)

[Postmortem 15](#_Toc446780870)

[What went right? 15](#_Toc446780871)

[What went wrong? 15](#_Toc446780872)

[What did I learn? 15](#_Toc446780873)

[Conclusion 16](#_Toc446780874)

[Future Work 17](#_Toc446780875)

[References 18](#_Toc446780876)

[Appendices 19](#_Toc446780877)

# Abstract

The purpose of this project is to evaluate whether or not having additional game features makes the game itself more appealing to the players.

The game is a real-time strategy game, with 3 game modes: Singleplayer, Multiplayer, and Simulation. There is a Tutorial provided in the game to help with the process of helping the players to understand the game rules, and how the game works.

The game unit editor, allowing players to fully customize the attributes of the game units. This feature is present in Singleplayer, Multiplayer, and Simulation Mode, thereby giving players the ability to customize and play around in any of the three modes provided.

To evaluate how appealing a game can be by adding an additional feature, there will be two versions of the game, a game build with the game unit editor, and another build without the game unit editor included. Analyzing how much time players have spent playing the game modes and editor will give a conclusion to see if the evaluation suggested is true.

# Acknowledgements

I would like to thank Dean O’Donnell as supervisor for providing guidance, and Brian Moriarty and Charles Rich as readers for providing assistances.

I would like to thank the volunteers and testers for their feedback. Their feedback helped to improve the game, and made the game as it is.

# Introduction

## Strategy vs. Tactics

The term, “Real-Time Strategy,” is used to describe a subgenre of Strategy games as “a type of strategy game where it closely resembles reality, in which time is limited, and if the player loses time, their opponents may have already taken advantage of it.”2 In other words, real-time strategy games are games where players execute their actions in real-time, without pausing or taking turns. The term was used since the late 1980s, at the time for describing what an action strategy game, *Cosmic Conquest* plays like in the table of contents of the publication magazine, *BYTE*.[[1]](#footnote-1) However, the cofounder of Westwood Studios, Brett Sperry, is mainly credited for using the term to market their game, *Dune II*.[[2]](#footnote-2) This is what we used to define the “real-time strategy” genre in video games.

Real-time strategy games are sometimes confused with real-time tactics, in terms of game mechanics and gameplay.[[3]](#footnote-3) Real-time tactics is a subgenre or a related genre of real-time strategy games, which removes the aspects of base-building, or in general, reducing the importance of macromanagement. 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.[[4]](#footnote-4)

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.[[5]](#footnote-5) 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.[[6]](#footnote-6)

Real-time tactics, on the other hand, is about the placements of units on the battlefields, the unit troop formations, and the exploitation of terrain and environment for tactical advantages against enemies. 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 is therefore encouraged to increase the likelihood the player succeeds in completing the game session.

## Inspiration

When evaluating real-time strategy games, it is pretty difficult to say which player is better than the others, when all players do not have any prior knowledge of the situation. We can therefore assume each player have equal, negligible levels of certainty to successfully execute mind games for tricking and deceiving others. This way, we are able to simplify many factors based on player intuition and subjective decisions that other players may or may not dare to play. Instead, we look to evaluating performances based on upgrades being applied to game units, in which the process of improving game unit performances fares with how well a player is when compared to the rest of the players or enemies. This is more apparent when players are confronted with other players with stronger army compositions and higher tiered units.[[7]](#footnote-7)

This leads us to the very core of determining the game balance, the variables of play. A typical real-time strategy game requires a lot of gameplay testing to see if units made are balanced for players to play with. Making the balancing process more streamlined for simulating real-time strategy units can be done by running algorithms to determine the most optimal unit attributes given. This process allows access to more unit diversity and game designs in the real-time strategy genre.

To come up with the best approach to do this, is by building a real-time strategy game using simple mathematical equations to determine usable unit's attributes, and assess the outcome. Whatever outcome it may be, will pave the way to future works in the realm of procedural content generation in real-time strategy unit balancing.

## Procedural Content Generation

Procedural content generation in real-time strategy games is one of the most interesting challenges in the video game development process.[[8]](#footnote-8) 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.

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.[[9]](#footnote-9) It has also been proven that it is possible to have automated content generation in mainstream games.[[10]](#footnote-10) Notable examples include *Minecraft*[[11]](#footnote-11) and *Mini Metro*[[12]](#footnote-12), in which the former uses procedural content generation to generate terrain, and the latter uses procedural audio generation.

## Game Balance and Related Works

Real-time strategy games are notoriously known for their high difficulty when it comes to game balancing.[[13]](#footnote-13) Players can choose amongst various factions and units with different strengths and weaknesses, developers must carefully test all potential interactions and ensure they are balanced and fair across different types of terrain, maps, game modes, and scenarios. Here, there is a particular interest in the concept of Nash equilibrium[[14]](#footnote-14), and related concepts of dominant strategies, in which there exists an equilibrium state where no players can benefit from changing their strategies. Meaning, players will tend to gravitate towards the most optimum strategy, or the dominant strategy. The existence of such strategy saps away the potential for choice, thus making the game boring to play.[[15]](#footnote-15)

Here, we look into balancing the game by having very few strategies for players to choose from, and allowing as few dominant strategies as possible, in order to minimize factors that may hinder the evaluations. 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.

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.[[16]](#footnote-16) 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.[[17]](#footnote-17) It also theorizes having moderate dynamics and moderate balancing can give ample stimuli to players to expand and to seek their enemies.

Games that have moderate dynamics and balancing can be used as references. *Total War: Shogun 2*[[18]](#footnote-18), *Total War: Attila*[[19]](#footnote-19), and *Multiwinia*[[20]](#footnote-20) 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 would be *Starcraft II*[[21]](#footnote-21), *Warcraft III*[[22]](#footnote-22), and *Total Annihilation*[[23]](#footnote-23). In these games, unit attributes are affected by unit dynamic properties (speed, regeneration, and cooldowns), which are incrementally increased through tech upgrades. It has been shown that unit attributes can determine the outcome of a real-time strategy multiplayer game session[[24]](#footnote-24).

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*[[25]](#footnote-25), which encourages the players to see further with higher ground, and to avoid lower ground from enemy fires, the player is given the option to use smoke screens to block enemy line of sight, thus preventing players from receiving excessive fires when retreating from enemy units.

Similarly, there are some real-time strategy games, such as *Auralux*[[26]](#footnote-26), which utilizes map layouts designed with a blend of *Footmen Wars*[[27]](#footnote-27)in mind. Research has been done exploring map layout and balance in real-time strategy games[[28]](#footnote-28), made similarly as *Auralux*.

The game, *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.

You can start to see many varieties of ways to approach game balance in real-time strategy games, but most of all, unit interaction is one of many core components of real-time strategy games.[[29]](#footnote-29) It is because of this, experimenting the possibilities of game balancing using mathematical equations is the main focus of this research project.

# Related Works

Prior works and research findings are to be placed in this section. In this case, may include prior game design analytics and postmortems, as well as developer conclusions and focus of problems that arise in other works.

# Game Design

This section contains the design document of the project. Each subsection goes further into detail of portions of the whole project design.

Can include UML diagrams of game logic workflows, and other aspects of the game (aesthetics, core, etc.)

## Overview

## Game Mechanics

## Other Things Worth Mentioning

# Resources

This section contains any game assets used in the project. Includes current assets and unused assets, as well as sections explaining the uses of the assets in general. Should go more in detail.

# Tools

This section discusses the use of Unity, and all resources related to Unity, Unity Networking, shortcomings and issues with Unity, and other advice worth sharing.

# Evaluation

The meat and grits of this paper. State the project’s goal, and come up with the hypothesis that goes into evaluating the project to be successful or failure. Subsections must go into detail of how the evaluation is done, and so forth.

## Research Method

## Research Question

## Result / Conclusion

# Postmortem

Typical game postmortem structure goes here. For reference, see Gamasutra postmortems.

## What went right?

## What went wrong?

## What did I learn?

# Conclusion

This section contains the final evaluated answer to the hypothesis stated in the Evaluation section. Shortcomings of this project is also included in this section. Make sure limitations are noted. Never gimp out on the details.

# Future Work

State the endless possibilities this project could have, assuming there are no deadlines and unlimited budgets are given. State when this project is deemed complete, and state what possible research can be made and for what other purposes.

Uncertain if this section should contain Github project repository links, and explanation on how to use the project.

# References

Adams, D. (2006, September 11). *Company of Heroes Review*. Retrieved from IGN: http://www.ign.com/articles/2006/09/11/company-of-heroes-review-2

Adams, E. (1998, October 16). *Designer's Notebook: A Symmetry Lesson*. Retrieved from Gamasutra: http://www.gamasutra.com/view/feature/131699/designers\_notebook\_a\_symmetry\_.php

Bangay, S., & Makin, O. (2013, September 23-25). Modelling Attribute Dependencies in Single Unit. *Games Innovation Conference (IGIC), 2013 IEEE International*, 20-26.

Bergensten, J. (2008, November 26). *RTS Game-play Part 5: Introduction to Unit Balancing*. Retrieved from Oxeye Game Studio News & Development Blog: http://www.oxeyegames.com/rts-game-play-part-5-introduction-to-unit-balancing/

Blackbird Interactive. (2016, March 26). *Homeworld: Deserts of Kharak*. Retrieved from Homeworld: Deserts of Kharak: http://www.desertsofkharak.com/

Blizzard Entertainment. (2002, July 3). *Warcraft 3: The Reign of Chaos*. Retrieved from Blizzard Entertainment: http://us.blizzard.com/en-us/games/war3/

Blizzard Entertainment. (2009, March 24). *Rookie Mistakes*. Retrieved from Battle.net: https://web.archive.org/web/20090324034745/http://classic.battle.net/war3/basics/rookiemistakes.shtml

Blizzard Entertainment. (2015). *StarCraft II*. Retrieved from Blizzard Entertainment: http://us.battle.net/sc2/en/

Byte Publications. (1982, December). Table of Contents. *Byte: The Small Systems Journal, 7*(12), p. 5. Retrieved March 20, 2016, from https://archive.org/stream/byte-magazine-1982-12/1982\_12\_BYTE\_07-12\_Game\_Plan\_1982#page/n3/mode/2up

Dinosaur Polo Club. (2015, August 28). *Mini Metro - Beta31: Audio!* Retrieved from Steam Community: http://steamcommunity.com/games/287980/announcements/detail/800867231024886989

Dulin, R. (1997, October 1). *Total Annihilation Review*. Retrieved from Gamespot: http://www.gamespot.com/reviews/total-annihilation-review/1900-2535174/

Egenfeldt-Nielsen, S., Smith, J. H., & Tosca, S. P. (2012). *Understanding Video Games: The Essential Introduction* (2nd ed.). New York, NY: Routledge.

Fayard, T. (2007). Using a Planner to Balance Real Time Strategy Video Game. *Workshop on Planning in Games , ICAPS, vol. 2005.*, 1-8.

Gallegos, A. (2011, November 23). *Minecraft Review*. Retrieved from IGN: http://www.ign.com/articles/2011/11/24/minecraft-review

Geryk, B. (2001, June 11). *A History of Real-Time Strategy Games*. Retrieved from Gamespot: https://web.archive.org/web/20010611023323/http://gamespot.com/gamespot/features/all/real\_time/index.html

Giant Bomb. (2016, March 26). *Macromanagement*. Retrieved from Giant Bomb: http://web.archive.org/web/20160326224102/http://www.giantbomb.com/macromanagement/3015-484/

Goetz, P. (2006, August 23). *Too Many Clicks! Unit-Based Interfaces Considered Harmful*. Retrieved from Gamasutra: http://www.gamasutra.com/view/feature/1839/too\_many\_clicks\_unitbased\_.php

Griliopoulos, D. (2008, September 16). *Multiwinia UK Review*. Retrieved from IGN: http://www.ign.com/articles/2008/09/16/multiwinia-uk-review

Hafer, T. (2015, February 12). *Total War: Attila Review*. Retrieved from IGN: http://www.ign.com/articles/2015/02/12/total-war-attila-review

Hastings, E. J., Guha, R. K., Member, L., IEEE, & Stanley, K. O. (2009, December). Automatic Content Generation in the Galactic Arms Race Video Game. *IEEE Trabsactions on Computational Intelligence and AI in Games, Vol. 1, No. 4*, 245-263.

Johnson, D. M. (2013, September 7). *Real-Time Strategy “Level Design”*. Retrieved from Ultima Ratio Regum: http://www.ultimaratioregum.co.uk/game/2013/09/07/real-time-strategy-level-design/

Kleinberg, J. (2011, September 23). *Networks: Course Blogs for INFO 2040/CS 2850/Econ 2040/SOC 2090*. Retrieved from Cornell University: http://blogs.cornell.edu/info2040/2011/09/23/real-time-strategy-and-game-theory/

Lahiri, S. (2010, October 4). *Mind Games of a Tactical Kind*. Retrieved from Slant Magazine: http://www.slantmagazine.com/house/article/mind-games-of-a-tactical-kind-ruse

Lara-Cabrera, R., Cotta, C., & Fernández-Leiva, A. J. (2013). A Procedural Balanced Map Generator with Self-adaptive Complexity for the Real-Time Strategy Game Planet Wars. *EvoApplications 2013, LNCS 7835*, 274–283.

Lara-Cabrera, R., Cotta, C., & Fernández-Leiva, A. J. (2014). On balance and dynamism in procedural content generation with self-adaptive evolutionary algorithms. *Springer Science+Business Media Dordrecht*, 157–168.

Lara-Cabrera, R., Nogueira-Collazo, M., Cotta, C., & Fernández-Leiva, A. J. (2015). Procedural Content Generation for Real-Time Strategy Games. *International Journal of Artificial Intelligence and Interactive Multimedia, Vol. 3, Nº 2.*, 40-48.

Li Yan, Y. S. (2014). An Interactive Path Planning Method Based on Fuzzy Potential Field in Game Scenarios. *Foundations of Intelligent Systems: Proceedings of the Eighth International Conference on Intelligent Systems and Knowledge Engineering* (pp. 519-529). Shenzhen, China: Springer Berlin Heidelberg.

Mark Hendrikx, S. M. (2013, February). Procedural Content Generation for Games: A Survey. *ACM Transactions on Multimedia Computing, Communications and Applications, Vol. 9, No. 1, Article 1*, 22.

Nash, J. F. (1950, January 15). Equilibrium Points in N-Person Games. *Proceedings of the National Academy of Sciences of the United States of America, 36*(1), 48-49. Retrieved March 26, 2013, from http://www.jstor.org/stable/88031

Onyett, C. (2007, February 16). *Supreme Commander Review*. Retrieved from IGN: http://www.ign.com/articles/2007/02/16/supreme-commander-review-2

Onyett, C. (2010, March 18). *Command & Conquer 4 Review*. Retrieved from IGN: http://www.ign.com/articles/2010/03/18/command-conquer-4-review?page=1

Onyett, C. (2011, March 16). *Total War: Shogun 2 Review*. Retrieved from IGN: http://www.ign.com/articles/2011/03/17/total-war-shogun-2-review

Parker, J. (2013, May 10). *Auralux Review*. Retrieved from CNET: http://www.cnet.com/products/auralux/

StrategyWiki. (2014, October 4). *Warcraft III: Reign of Chaos/Footmen Wars*. Retrieved from Wayback Machine: https://web.archive.org/web/20141004065215/http://strategywiki.org/wiki/Warcraft\_III:\_Reign\_of\_Chaos/Footmen\_Wars

The Numerical Algorithms Group Ltd. (2012). *Random Number Generators.* Retrieved September 17, 2015, from NAG Library Manual, Mark 23 Online Documentation: http://www.nag.co.uk/numeric/fl/nagdoc\_fl23/pdf/G05/g05intro.pdf

Tocci, J. (2012, April 19). *Five Ways Games Appeal to Players*. Retrieved from Gamasutra: http://gamasutra.com/view/feature/168807/five\_ways\_games\_appeal\_to\_players.php

Walker, M. H. (2004, August 18). *Strategy Gaming: Part V -- Real-Time vs. Turn-Based*. Retrieved from Gamespy: http://web.archive.org/web/20040818124742/http://archive.gamespy.com/articles/february02/strategygames05/

Wayward Strategist. (2014, December 18). *Random Thoughts on Resource Management in RTS*. Retrieved from Wayward Strategist: http://waywardstrategist.com/2014/12/18/random-thoughts-on-resource-management-in-rts/

# 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. (Byte Publications, 1982) [↑](#footnote-ref-1)
2. (Geryk, 2001) [↑](#footnote-ref-2)
3. (Walker, 2004) [↑](#footnote-ref-3)
4. (Giant Bomb, 2016). Macromanagement is derived from micromanagement in real-time strategy games. [↑](#footnote-ref-4)
5. (Kleinberg, 2011) [↑](#footnote-ref-5)
6. (Lahiri, 2010) [↑](#footnote-ref-6)
7. (Blizzard Entertainment, 2009) [↑](#footnote-ref-7)
8. (Lara-Cabrera, Nogueira-Collazo, Cotta, & Fernández-Leiva, 2015) [↑](#footnote-ref-8)
9. (Mark Hendrikx, 2013) [↑](#footnote-ref-9)
10. (Hastings, Guha, Member, IEEE, & Stanley, 2009) [↑](#footnote-ref-10)
11. (Gallegos, 2011) [↑](#footnote-ref-11)
12. (Dinosaur Polo Club, 2015) [↑](#footnote-ref-12)
13. (Egenfeldt-Nielsen, Smith, & Tosca, 2012) [↑](#footnote-ref-13)
14. (Nash, 1950) [↑](#footnote-ref-14)
15. (Egenfeldt-Nielsen, Smith, & Tosca, 2012) [↑](#footnote-ref-15)
16. (Fayard, 2007) [↑](#footnote-ref-16)
17. (Lara-Cabrera, Cotta, & Fernández-Leiva, On balance and dynamism in procedural content generation with self-adaptive evolutionary algorithms, 2014) [↑](#footnote-ref-17)
18. (Onyett, Total War: Shogun 2 Review, 2011) [↑](#footnote-ref-18)
19. (Hafer, 2015) [↑](#footnote-ref-19)
20. (Griliopoulos, 2008) [↑](#footnote-ref-20)
21. (Blizzard Entertainment, 2015) [↑](#footnote-ref-21)
22. (Blizzard Entertainment, 2002) [↑](#footnote-ref-22)
23. (Dulin, 1997) [↑](#footnote-ref-23)
24. (Bangay & Makin, 2013) [↑](#footnote-ref-24)
25. (Blackbird Interactive, 2016) [↑](#footnote-ref-25)
26. A minimalistic real-time strategy game for Android, based in outer space. (Parker, 2013) [↑](#footnote-ref-26)
27. 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-27)
28. (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-28)
29. Unit interaction is discussed in the Introduction of (Li Yan, 2014). [↑](#footnote-ref-29)