Does Damage Have a Value?
An Analysis of the Economy in *StarCraft II: Heart of the Swarm*

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Abstract

This study aims to see if it is feasible, for the purpose of studying game balance, to put a concrete value on damage and other abilities in Real-Time Strategy (RTS) games. The main metric that was used for this analysis was the cost per DPS (Damage Per Second) for units in a RTS game. The game that was used to test this analysis was *StarCraft II: Heart of the Swarm*.

This topic was tested by first gathering data about the properties of units in the game and then calculating the average values of the units in the game. After that, a few units and game mechanics were chosen to be analyzed in further detail. They were analyzed by comparing their cost/DPS values to the average values and seeing if there were any other properties that might have an impact in the cost of a unit.

While it was concluded that it is feasible to put a value on damage and other properties of units, the subject needs to be approached with caution. Using the cost/DPS metric that was assumed for this thesis, some units came out as being too strong for their cost. Further studies on similar topics might be able to find better methodologies for approaching similar analyses.

**Keywords:** Real-time strategy, game design, economics in games, computer games, game balance
Sammanfattning

Denna studie vill titta på om det är rimligt, för ändamålet att studera spelbalans, att sätta ett konkret värde på skada och andra förmågor i Realtidsstrategispel. Det huvudsakliga mätsättet som användes i denna analys var kostnaden per skada per sekund (DPS, Damage per Second på engelska) för enheter i Realtidsstrategispel. Spelet som användes för att testa denna analys var StarCraft II: Heart of the Swarm.

Studien genomfördes genom att först samla in data om enheternas egenskaper och sedan räkna ut genomsnittsvärden för enheterna i spelet. Efter det så valdes några enheter och spelmekaniker ut för att analyseras i mer detalj. De var analyserade genom att jämföra vad de hade för förhållande mellan sin kostnad och deras DPS-värden med det genomsnittliga och se om de hade andra egenskaper som kunde ha påverkat enhetens kostnad.

Även om slutsatsen som drogs var att det är rimligt att sätta ett värde på skada och andra egenskaper hos enheter så måste man vara försiktigt om man vill studera detta ämne. Genom att använda sig utav kostnad/DPS värden som användes för denna analys så kom vissa enheter att se väldigt starka ut i förhållande till vad de kostar. Vidare studier på liknande ämnen kan hitta bättre sätt att närma sig liknande analyser.

Nyckelord: Realtidsstrategi, speldesign, ekonomi i spel, datorspel, spelbalans
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Explanation of terms

Below is a list of terms and abbreviations that are used throughout this report.

- **DPS**: Damage per Second. In games, this is a measure of how much damage a unit deals in relation to how powerful its attack is and how long the unit has to wait before the attack can fire again. DPS is calculated in the following manner: [Damage that the attack does] / [The Cooldown of the attack]
  - For example, a unit that has an attack that deals 10 damage with a cooldown of 1 second has a DPS of 10.
  - Likewise, an attack that deals 5 damage every 0.5 second also has a DPS of 10.
- **SCV**: Space Construction Vehicle. The Terran race’s worker unit in *StarCraft II: Heart of the Swarm*. 
1 Introduction

This thesis looks at whether it is feasible to put a value at damage and other abilities for units in RTS games. It will also look at if it is feasible to standardize multiple different resources into a single, unified resource in order to simplify the calculations and analysis of costs. The game looked at in this thesis is StarCraft II: Heart of the Swarm. The reason for focusing on StarCraft II in particular is because it is a popular game in its genre.

The main thing that this thesis looks at is what DPS the units in StarCraft II have in relation to what they cost and if it is a feasible way to approach game balance on. If a unit’s cost per DPS value is better or worse compared to the average, I look at whether there is something that makes the unit cost more (like special abilities) or if the unit has some drawback for having a good cost per DPS ratio so that it is not overpowered for its cost. The main goal here is to see if this is a feasible approach to put a concrete value on damage, special abilities and drawbacks for the units in the game.

The analysis in this thesis is not a complete one; due to the time available for the thesis. The analysis will therefore only cover parts of StarCraft II.
2 Background

This section will contain some background information that is needed to understand the study better.

2.1 Real Time Strategy Games

In the third edition of *Fundamentals of Game Design*, Ernest Adams defines strategy as:
“Strategy means planning, including taking advantage of your situation and resources, anticipating your opponent’s moves, and knowing and minimizing your weaknesses. A strategic challenge requires the player to carefully consider the game (a process called situational analysis) and devise a plan of action.” (Adams 2014a:339)

In *Fundamentals of Strategy Game Design*, Ernest Adams gives the following definition of what a strategy game is:

Strategy games are ones in which the majority of challenges presented are strategic conflict challenges, and the player may choose from a large variety of potential actions or moves at most points in the game. Victory is attained by superior planning and taking the optimum actions; the element of chance must not play a large role. Other challenges, such as tactical, logistical, economic, and exploration challenges, may also be present. (Adams 2014b:5)

Later on, Adams states that “RTSs added time pressure to strategy games because everything happens at once and players do not have individual turns to ponder their moves. […] RTSs require the player to keep a sharp lookout and to think quickly” (Adams 2014b:8).

Blizzard Entertainment, the developer and publisher of *StarCraft II: Heart of the Swarm* gives the following definition of what a real-time strategy game is:

In typical real-time strategy games, players build armies and vie for control of the battlefield. The armies in play can be as small as a single squad of Marines or as large as a full-blown planetary invasion force. As commander, you observe the battlefield from a top-down perspective and issue orders to your units in real time. Strategic thinking is key to success; you need to gather information about your opponents, anticipate their moves, outflank their attacks, and formulate a winning strategy (Blizzard Entertainment)

The goal of RTS is usually to take down your enemy’s units and buildings. This is accomplished by first building up a base that is used for gathering resources and producing unit that you are in command of. The player then uses the units he has to take down his enemy’s units and eventually the enemy’s base as well. A player can also concede if he feels like he has no chance of winning the game. *StarCraft II: Heart of the Swarm* has this as its goal in some variation.

2.2 StarCraft II: Heart of the Swarm

*StarCraft II: Heart of the Swarm* is an RTS game developed and published by Blizzard Entertainment that was released in 2013. The game is an expansion to the 2010 game
StarCraft II: Wings of Liberty (also developed and published by Blizzard Entertainment). The game features three different races, the Protoss, Terran and Zerg. StarCraft II is a highly deterministic game, for which Aarseth et.al. gives the following definition: “A deterministic game is one that invariably produces the same result at a given position if the player input is identical each time” (Aarseth et.al. 2003:52). As a result of being highly deterministic, it simplifies the calculations used in the analysis.

One important concept in the analysis of StarCraft II is armor. For each point of armor a building or unit has, it will reduce that amount of damage from each source of incoming damage by that amount (StarCraft II Liquidpedia). This means that if a building has 1 armor and is attacked by an attack with a damage value of 10, the attack will now only deal 9 damage. This would also mean that if a unit has two attacks each dealing 5 damage and it attacks with both at the same time, both would be reduced to 4 damage against buildings/units with 1 armor (Meaning that the unit deals 8 damage in total to a unit or building with 1 armor). Regardless of armor and attack values though, each source of attack will always deal at least 0.5 damage (StarCraft II Liquidpedia).

Image 1: A screenshot from the beginning of a training game in StarCraft II: Heart of the Swarm (Blizzard Entertainment. Screenshot by Axel Räntilä)
3 Method

This section explains how the analysis of StarCraft II: Heart of the Swarm was approached.

3.1 Gathering Data about the Games

The first step of the process involved gathering data about the games that were going to be analyzed. Since this is a study about internal economics in games, the main data that was looked at was the various properties of the units in the game; as well as data related to resource-gathering in the games. Once the data was found, it was then entered into a Microsoft Excel spreadsheet.

3.2 Analyzing the StarCraft II data

After all the data had been gathered about the units in StarCraft II: Heart of the Swarm, average values were calculated for the various properties of the units. The average values for various properties related to damage, cost and health of the units was calculated. The average values were both calculated for each individual race in the game, as well as by a total game average. The average calculations were done through the built-in calculation tools in Microsoft Excel.

When the average values were calculated in various ways, the data analysis process began. The key part of the analysis was comparing each unit’s DPS per cost value against what the averages were and seeing if there is something that makes the unit cost more or less. This could include better properties in other areas or any eventual abilities the unit might have. Because of the limited time available for this thesis, it was decided to only analyze parts of the game.

The reason for looking at the DPS values of the units was because it combines two values that effects how much damage a unit deals (Damage per attack and the attack rate) into a single measurable unit. The reason for looking at the DPS values against 1 armor was because it was also looked into how quickly each unit could take down a Zerg building called Hatchery alone, which has 1 armor. The reason for looking at the Hatchery in particular is because it is one of the main base buildings in the game; and among the main buildings in the game its properties is constant, which makes comparison among units easier.
4 Result

This section presents how the analysis was approached, as well as presenting some of the most important data that was gathered for the study. All numbers are rounded to the decimal point that they are written with.

4.1 Decision on How to look at the Data

This section will present the decisions that were made with regard to how the data was looked at.

It was decided that the damage per second (DPS) of each unit was going to be one comparison variable. The reason for looking at the DPS of the units is because StarCraft II: Heart of the Swarm counts as an RTS game. A strategy game without any combat would more properly count as a construction and management simulation game (Adams 2014b:10). DPS is important in RTS game because the end goal of a RTS game is (usually) to take down the enemy’s units and buildings. The greater DPS a unit has, the more quickly they can take down other units and buildings.

For units that suicide when they attack, it was decided that their DPS was equal to what their attack was; meaning that they were treated as having an attack cooldown of 1 second for the purpose of DPS calculations.

In addition to looking at the DPS values, it was decided that for StarCraft II: Heart of the Swarm to also look at how long it takes for units to take down the Zerg building called Hatchery (The Zerg is one of the three playable races in the game alongside the Protoss and the Terran). The reason for choosing this particular main building is because its properties are constant; which is not the case with the other two races’ main buildings in the game.

Two properties that were left out of the equation were the health and speed of the units. These properties were left out because the main focus in this thesis is on the offensive properties of the units. While these properties are also important to units (Adams 2014b:27-32), they will not be taken into consideration in this analysis.

For units that are created from other units in one way or another, the cost of the unit was decided to be the cost of the total chain.

The units Brood Lord and Carrier (for the Zerg and Protoss respectively) were left out of the analysis and calculations completely. The reason for this was because their DPS is not constant and depends on too many factors to be easily comparable against other units that have a constant DPS.

StarCraft II: Heart of the Swarm features two different resources, minerals and gas. In order to simplify the analysis, it was decided to normalize both of the resources into a single resource (that for the sake of simplicity will be called just resource). It was assumed that one unit of mineral was worth one resource. One unit of gas was assumed to be worth 1.6
resources (The exact number was slightly smaller but it was used correctly in the calculations).

At each base in the game, there is a total of 12000 minerals and 5000 gas. The total cost of all units in the game is 8225 minerals and 5820 gas. By dividing the total supply with the total demand for each resource, we get a ratio where the higher it is, the less valuable the resource is. This means that minerals has supply/demand ratio of 1.46 while gas has a supply/demand ratio of 0.86. The difference between these ratios is 0.6. Since gas is a more valuable resource according to these calculations, it was decided that one unit of gas was worth 1.6 resources.

4.2 Decisions on How the Data Was Analyzed

The key property of the units in the game that was analyzed was the DPS of each unit. Also considered was how long it would take for each unit to take down the Zerg building Hatchery alone (in seconds). This was calculated by using this formula: \( \frac{1500}{([\text{The Unit’s DPS vs. 1 armor]} - 0.27)} \). The reason for using this formula was because the Hatchery has 1500 HP and the reason for dividing that with the adjusted DPS of the unit was to see how long it would take for the unit to take down the hatchery. The DPS against 1 armor was used because the Hatchery has 1 armor. The reason for subtracting that DPS by 0.27 is because the Hatchery has a constant health regeneration of 0.27 HP/second.

The DPS value was then compared to the cost of the unit, and then to the average cost for all units in the game. The reason for doing it this way was because if the cost per DPS ratio of a unit was worse or better than the average, there might be reason to why it was that way. The difference compared to the average value can give an estimated value for things like special abilities or drawbacks. The ratio between a unit’s DPS and its total cost was assumed to be linear.

Properties that were also taken into consideration included the attack range of the unit (meaning how far away the unit can attack another unit), the health of the unit, whenever it could attack both ground and air units and how long time it would take to build the unit. Any additional abilities that were not pure numeric properties were also looked at and taken into consideration.

4.3 Data Gathered from StarCraft II

The properties about the units and buildings in StarCraft II: Heart of the Swarm was gathered from the site TeamLiquid.net’s wiki about StarCraft II (Called Liquidpedia). The reason for choosing this site’s wiki in particular is because TeamLiquid is a large community for the StarCraft franchise. TeamLiquid has also arranged competitions for StarCraft II together with Blizzard Entertainment, the developers of the game (TeamLiquid.net).
This section summarizes the most important data that was gathered. For full data about the games (with the properties for the individual units), see the attached Excel spreadsheet and Appendix A for more information regarding the data in the spreadsheet.

<table>
<thead>
<tr>
<th></th>
<th>Mineral cost</th>
<th>Gas cost</th>
<th>Total resource cost</th>
<th>DPS v. 1 armor (excluding suicidal units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Average</td>
<td>152</td>
<td>110</td>
<td>325</td>
<td>16</td>
</tr>
<tr>
<td>Protoss Average</td>
<td>171</td>
<td>142</td>
<td>398</td>
<td>11</td>
</tr>
<tr>
<td>Terran Average</td>
<td>169</td>
<td>110</td>
<td>344</td>
<td>18 (13)</td>
</tr>
<tr>
<td>Zerg Average</td>
<td>107</td>
<td>66</td>
<td>205</td>
<td>18 (12)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cost/DPS</th>
<th>Time to take down Hatchery (s) (without suicidal units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Average</td>
<td>30</td>
<td>195</td>
</tr>
<tr>
<td>Protoss Average</td>
<td>39</td>
<td>185</td>
</tr>
<tr>
<td>Terran Average</td>
<td>30</td>
<td>202 (212)</td>
</tr>
<tr>
<td>Zerg Average</td>
<td>17</td>
<td>198 (207)</td>
</tr>
</tbody>
</table>

5 Analysis

All DPS values in the StarCraft II: Heart of the Swarm analysis sections are against buildings/units with 1 armor. Properties expressed in numbers are rounded to the decimal point that they are written with.

This analysis assumes that it is a 1v1 combat. For example, even though a Medivac (a unit for the Terran race that can be used for both transporting other units and healing a player’s biological units) can heal allied units as well in team games, even from other races, all analysis will treat this as a 1v1 combat (more info about the Medivac is available in section 5.2.2).

5.1 Possible Sources of Error

I personally believe that there are a few possible sources of errors with the data used in the thesis or the way the analysis was approached that might impact on how the results looked like.

5.1.1 Units with Multiple Weapons

There are a few units in StarCraft II that have multiple weapons of attack. In the end I ended up counting each different kind of attack as a separate unit. The reason for choosing this was because either it was two different modes for that unit (meaning that it could not use both at the same time) or a different attack for ground units and air units. Examples of the former include the Terran unit Siege Tank and example of the later includes the Zerg unit Queen.

5.1.2 Suicidal Units

Another thing that I was not entirely sure how to deal with was units that suicide when they attack. The reason this is a problem is because it makes it hard to calculate DPS values properly (as it can be anything as a result of the unit suiciding) as they only attack once, but usually do lots of damage when doing so.

In the end, I ended up treating suicidal units as having an attack cool-down of one second. This also means that the time required to take down a main building/unit is how many of those units would be required if they a new one attacked once every second. While not perfect, as it made the average DPS values in some situations a lot higher compared to what they looked like without the suicidal units, I could not think of a better way to treat suicidal units’ DPS values. I also decided to calculate the average DPS values without the suicidal units to see how big of a difference it would make.
5.1.3 Units with Complex DPS Calculations

Some units had to be left out of the analysis altogether. The reason for this is that some of them have too many variables that determine their DPS, and this makes them hard to compare against other units. One example of this is the Protoss Carrier unit in StarCraft II: Heart of the Swarm. The Carrier can have zero to eight so-called Interceptors out at the same time. And since it’s the Interceptors that deal the damage for the Carrier, the DPS of the Carrier can vary greatly. Another unit that had to be left out for having a similar issue is the Zerg unit Brood Lord, as the number of so-called Broodlings that fly alongside it when it attacks determines how large the DPS is.

5.1.4 Units Created from Other Units

Some of the units in the game are created from other units. For example, the Zerg unit Baneling is created by morphing a Zergling into one. For the purpose of this study, I decided that the resource and time cost for units created from other units to be the total chain of required resources and time. For example, in case of the Baneling unit, the total cost would be 50 minerals, 25 gas and 44 seconds build time. Of those, 25 minerals and 24 seconds is the build cost and time of the Zergling.

5.1.5 Looking Purely at Properties of the Units

Another potential problem with the analysis of StarCraft II: Heart of the Swarm is that we are only looking at the base values of the units and not taking upgrades and bonus damages into consideration when making the analysis. In StarCraft II, many units deal bonus damage against certain kinds of units (For example, the Protoss Archon unit does bonus damage against units that count as biological units). The reason for only looking at base values is because if we take into consideration every possible upgrade there is in the game, there would be too many variables to make it feasible to analyze.

The Protoss Nexus (The Protoss’ main building) can use an ability called Chronoboost on buildings (including itself) to speed up the production time. For the Protoss Gateway (The first building that produces Protoss combat units), once the Warp Gate upgrade has been researched, Gateways can transform into Warp Gates. This allows Protoss to warp in any Gateway unit in five seconds. Once the warp-in has finished, there is a cooldown (equal to the units’ normal build time) before a new unit can be warped in again. And here, Chronoboost can be used to decrease the cooldown time.

Another issue with just looking at the various properties of the units is that this does not take into consideration things like level design which might very well impact how useful a unit is beyond just its properties.
5.1.6 Not Taking Tech Trees into Consideration

Another issue with this approach is that it does not take into consideration the so-called tech trees of the units in the analysis. A tech tree is an in-game chain of dependencies required to be able to construct a unit. It may be the case that units that have more dependencies are intentionally more powerful as a result of the player having to spend more resources in order to be able to construct them in the first place.

5.2 StarCraft II: Heart of the Swarm reflections

The following section will contain analysis of *StarCraft II: Heart of the Swarm*.

Even though the three worker units (Probe, SCV and Drone for the Protoss, Terran and Zerg respectively) each have an attack, I don’t consider them to be combat units since they are intended to be worker units. I consider non-combat units to be worker units or units that have no way of dealing damage to other units. For example, I consider the Protoss Observer unit to be a non-combat unit (as it has no way to deal damage) but not the High Templar unit (as it has two abilities that it can deal damage with even if it does not have any normal attacks).

5.2.1 Protoss Analysis

In the game all Protoss units and buildings have Plasma Shields (*StarCraft II Liquidpedia*). The Plasma Shield acts as an extra layer of health points before normal health points (*StarCraft II Liquidpedia*). If a Protoss unit or building hasn’t taken damage for 10 seconds, the plasma shield will regenerate at a rate of 2 points per second (*StarCraft II Liquidpedia*). It is also worth noting that the Protoss (in 1v1 games) have no way to recover normal health, even though their shields can.

The average total cost for units in the game are 325 resources while the Protoss average is 398. Ignoring suicidal units, the DPS is approximately the same between the three races in the game. This would mean that the shield of Protoss units is roughly worth 75 resources. The average shield points of the Protoss units in the game are 132 shield HP.

![Image 2: a Dark Templar (Blizzard Entertainment. Screenshot by Axel Räntilä). For Protoss units the blue bar represents the hit points of the Plasma Shields and the green bar represents the normal health.](image)
The Dark Templar is a unit whose cost is 325 resources, which is the same as the average cost of a unit in the game. And despite this, the Dark Templar has the best base DPS of any Protoss unit at almost 26 DPS, on top of being permanently invisible (meaning that the enemy would need some kind of detection to spot them). Compared to the average cost/DPS value, the Dark Templar would need to cost 782 resources. So why is it that the Dark Templar seems so strong for its cost?

Among all the Protoss combat units, the Dark Templar has the third lowest health in the entire game (after the Sentry and the High Templar). The Dark Templar also has a fairly long build time at 55 seconds (the average in the game is 49 seconds). So in the case of Dark Templar, the player trades approximately 460 resources worth of high DPS and permanent invisibility cloaking for long build time and low health. And once the opponent is aware that the player has Dark Templars, she usually starts putting up some kind of detection, meaning that the player has lost the element of surprise that Dark Templars can have with their permanent invisibility.

Image 3: a Mothership with full energy (Blizzard Entertainment. Screenshot by Axel Räntilä). The purple bar represents how much energy a unit has.

The unit Mothership is the most expensive Protoss unit in the game with a total cost of 400 minerals and 400 gas (which equals a worth of 1040 resources). The DPS of the Mothership is however only 13.6, meaning that the “ideal” cost of the Mothership would be 409 resources. The Mothership does however have three abilities. The first one is a passive one that cloaks nearby units and buildings invisible (which requires the opponent to have detection in order to see it). The second ability allows enemy units be slowed down within an area of effect. The last ability teleports the Mothership and the player’s units near the Mothership to a Nexus that the player controls. This would mean that the three abilities of the Mothership are worth 631 resources.

The Archon unit is unique in the sense that it is the only unit in the game that is created by merging two other units together. The Archon is created by merging two Dark Templar and/or High Templar units together. Any combination of Templars will create the same kind of
Archon with the same properties (Although the cost for creating one will vary depending on the combination of Templars being used). The average cost of creating on Archon is 648 resources. Archons have a DPS of 13.7, which means that its cost/DPS ratio is 47.4 resources per DPS. Assuming that the Archon would follow the game’s average cost/DPS value, it should have cost 412 resources.

The Archon does have some other benefits though that might make up for being approximately 230 resources too cheap when looking at its DPS. The Archon is a ranged unit. The attack deals splash damage (meaning that it also deals damage to units that are nearby the unit it attacks) and it can attack both ground and air units. The Archon is also unique in the sense that it does not require any particular building in itself to be created (Although it does so indirectly since the Templars have their own respective building as a requirement in order to construct them). The Archon can also allow a player to recycle High Templars that have run out of energy in the heat of battle or Dark Templars that have been detected. The Archon’s total health (especially its Plasma Shields) is also considerably higher than that of any two Templars combined.

Image 4: an Archon (Blizzard Entertainment. Screenshot by Axel Räntilä)

5.2.2 Terran Analysis

Terran units and buildings have the ability to be repaired (by SCVs if they are mechanical) or healed (by Medivacs if they are biological). Repairing costs resources while healing drains a Medivac’s energy. Repairing a unit from 1 point of health to full health cost 25% of the unit’s original cost (StarCraft II Liquidpedia). The time to repair the unit/building to full health is
equal to the unit’s build time (StarCraft II Liquidpedia). The cost and repair from other values
time scales linearly (StarCraft II Liquidpedia).

Image 5: a Medivac with full energy (Blizzard Entertainment. Screenshot by Axel Räntilä)

In addition to being able to transport land units, the Medivac has the ability to heal friendly
biological units at a rate of 9HP/s (StarCraft II Liquidpedia). The healing does consume
energy at a rate of 1 energy per 3HP healed (StarCraft II Liquidpedia). The Medivac begins
with 50 energy and recovers energy at rate of 0.5625 energy/second up a total of 200 energy
(StarCraft II Liquidpedia). 0.5625 energy per second translates into 9 energy every 16
seconds. This means that it is capable of healing 150HP when created and theoretically
1.6875 HP every second thereafter.

The average health of the Terran’s biological units is 75, meaning that the medivac is capable
of healing up two units after it has been created, and another one every 44.4 seconds
thereafter. The Medivac costs 260 resources to build and the average cost of the Terran’s
biological units are 146 resources. Given that the Medivac is capable of healing two units
when created, the cost of the Medivac per unit healed (130 resources) is somewhat close to
the average cost of a biological Terran unit. The difference of 16 resources per unit healed is
most likely because the healing is not instant.

Image 6: A Siege Tank in Mobile Mode (Blizzard Entertainment. Screenshot by Axel Räntilä)

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One unit that has two different attack modes is the Siege Tank. The two different modes are called Mobile and Siege Mode respectively. Both modes are only capable of attacking ground units. Compared to the average Mineral cost/DPS value (30.1), the siege tank has slightly lower values (24.3/26.9 in mobile/siege mode, 25.6 average). The reason for this is most likely because the Siege Tank has a rather large number of building requirements in order to be able to construct it in the first place.

![Image 7: A Thor (Blizzard Entertainment. Screenshot by Axel Rääntlä)](image)

The Thor has the most different attacks of any units in the game (one ground attack and two different air attacks). The ground attack is the highest of any non-suicidal DPS units in the game at 45.3. The two air attack modes however, Explosive and High Impact, are not as high as the ground attack at 6.7 and 11.5 respectively (9.1 average). Compared to the game average value of 30.1 resources/DPS, the ground attack of the Thor could be valued at 13.7 resources/DPS while the average value of the air attacks is 73.5 resources per DPS.

This would mean that the air attacks may initially not seem to be that good. There are however a couple of factors beyond the DPS that need to be taken into consideration when looking at the Thor. The air attacks do have a rather long range. The Explosive mode air attack does splash damage and can therefore be useful against large masses of air units. The High Impact mode can be used against single massive air units. So while this would mean the air attacks on average are 347 minerals more expensive than the average values, the extra minerals go towards being flexible with choosing between the different Air Attacks, as well as having a very powerful ground attack.

### 5.2.3 Zerg Analysis

All Zerg units and buildings have base health regeneration of 0.27 HP/second, with the Mutalisk having a higher base Regeneration of 1 HP/second (StarCraft II Liquidpedia). And unlike the Protoss Plasma Shields, the regeneration is always active (StarCraft II Liquidpedia).
The Zerg units do have lower average health compared to the other two races (at 122 HP compared to 190 HP for the Terran and 107 HP plus 132 Plasma Shield HP for the Protoss) even though the average non-suicidal DPS is about the same between the three races. The Zerg units are however approximately 165 resources cheaper on average compared to the other races and they also have the shortest average build time of the races in the game (at 37 seconds compared to 54.3 seconds for the other races). This would mean that constant health regeneration and quick build times are compensated for by the Zerg units having the lowest health.

Image 8: A Mutalisk (Blizzard Entertainment. Screenshot by Axel Räntilä)

The Mutalisk unit has a total cost of 260 resources and a base DPS of 5.25. This means that its DPS/cost ratio is not that great (49.5 minerals/DPS, compared to 30.1 for the game’s average). Ideally, it would cost about 158 minerals if it were to follow the average cost/DPS values. However, the attack of the Mutalisk bounces two times to a new target after the initial hit and it loses one third of the damage each time. This would mean that if the attacks could find a new target to bounce to the effective DPS would be 7.58 DPS (Which would mean that one DPS would cost about 34.3 resources). This means that the cost of having the attack bouncing (plus the fact that the Mutalisk have higher base health regen than the other Zerg units) is worth about 100 resources.

Image 9: A Zergling (Blizzard Entertainment. Screenshot by Axel Räntilä)
The Zergling has the lowest cost per DPS ratio in the entire game at 4.35 resources per DPS (25 minerals to build, 5.75 in DPS). If a single Zergling were to cost according to the average DPS values in the game, it would cost 173 minerals to build. The trade-off for the Zergling being 148 minerals too cheap in relation to the DPS is that it has very low total health (only the Baneling has lower total health among the combat units).

5.2.4 Comparison of Starting Units

This section will compare the three starting combat units in the game. These units are the Zealot for the Protoss, Marine for the Terran and Zergling for the Zerg. The reason I consider these to be the starting combat unit is because these units are the first combat unit the player can use with the different races.

Image 10: A Zealot (Blizzard Entertainment. Screenshot by Axel Räntilä)

The Zealot is the Protoss’s starting unit. Among the starting units, this is the most expensive unit with a cost of 100 minerals and a build time of 38 seconds. The Zealot does however have the greatest amount of DPS among the units at 11.67 against 1 armor. The Zealot has the most health of all the starting units at 100 health points and 50 Shield points.

The Zergling is the Zerg’s starting unit. One pair of Zerglings costs 50 minerals and has a build time of 24 seconds. Each of the Zerglings has 35 health points and a DPS of 5.75 against 1 armor.

Image 11: A Marine (Blizzard Entertainment. Screenshot by Axel Räntilä)

The Marine is the Terran’s starting unit. This is the only of the three starting unit that has a ranged attack. It is also the only of the three units that is capable of attacking air units. The
Marine costs 50 minerals and has a DPS of 5.81 against 1 armor. The marine has a health of 45 HP.

I believe there is a balance between the different races starting units in different ways. While the Zealot is the most powerful and highest damage dealing of the three, its high cost and long build time makes up for it. The fact that the Zergling can seem rather powerful for its cost is made up by the fact that each Zergling has very low health. And while the Marine seems to fit in-between the others with regards to DPS and health, the Marine does have a ranged attack that can also attack air units, something that the other starting units lack.

5.3 Analysis of the Methodology Used

The case with the Zergling (in section 5.2.3) suggests that the approach in this analysis might not be an ideal one. For example, assuming that the DPS/cost ratio is linear across the board might not have been a good idea. Maybe there are other factors that impact the design choices made in games; like the Zerg having a limited amount of Larva at their main buildings (all Zerg units, with exception of the Queen and units created from other units require Larva in order to be created). While I don’t think that is a useless methodology for analysis, it certainly is not a perfect one. I do however believe that further studies in the field around this (or similar) subjects might lead to finding a better methodology to approach the matter.

Another case that makes me believe that the approach used in this analysis may not have been the best one is the Thor (in section 5.2.2). The Thor does have a very powerful ground attack, as well as great flexibility when it comes to air attacks. It is however one of the later units in the Terran tech-tree, meaning that the player would have needed to invest resources into the required buildings in order to be able to build it at all.

I do feel that more properties than just DPS need to be looked at when making this kind of analysis. This particular analysis does not take into consideration the health and the speed of the units. While they are also important to a RTS game, they were not taken into consideration in this analysis.

Some properties can be considered to be quantitative (like the DPS of the units) and some can be considered qualitative (like special abilities. See section 5.2.1 for an example of this with the Mothership unit). While I believe that it is easy to put a value on quantitative resources, it can be fairly hard to put a value on qualitative properties. For example, while the Protoss unit Mothership may not look strong from a quantitative perspective when looking at its cost/DPS ratio, I think that the mothership can be a strong unit from a qualitative perspective with its three different special abilities.

I feel that using time to take down a base building (in the case of this analysis a Zerg Hatchery) can be used as a complement in addition to looking at the DPS values. In the case of StarCraft II: Heart of the Swarm, the difference in average DPS between the different races is only approximately 2 DPS (ignoring suicidal units), which may not seem that great at first glance. The difference in the time it takes to bring down a Hatchery however is almost 30 seconds between the slowest and the faster races. This can be important since the average
build time of a unit in the game is 49 seconds. While DPS values and the like are important when making these kinds of analyses, they need to be complemented by some other form of metric as well. Even though the time required to take down a Hatchery is still decided by the DPS of the unit in the end (the higher the DPS, the more quickly it can take down a Hatchery), it might allow the player to more easily see what impact even small amounts of DPS increments can lead to big difference in the greater scheme of things, even though it may not seem like that initially when just looking at the various DPS values.

Whenever it is important to focus on the difference between the races/factions in a game, I would say that it depends greatly on how the game is designed. In StarCraft II: Heart of the Swarm, I would consider it to be good to focus on the difference between the races as they are clearly distinguished from each other in certain ways.

I feel that only looking at the base properties of the units (meaning that upgrades and any eventual bonus damages are not taken into consideration) was a good decision in StarCraft II for the time available for this analysis. When I gathered the data about the units I saw that there were a lot of upgrades for the various units that made them better in some way. Taking all of that would mean that there would be too many variables to be reasonable to analyze in the time frame available for this thesis. While they certainly have in impact on the game, the scope of taking those things into consideration as well would have been too much.

When it comes to treating 1 unit of gas being worth approximately 1.6 minerals, and converting both of them into a single resources, I feel that it is something that could work for this kind of analysis. Even though it may not have been a perfect number, it still simplifies the analysis by making everything into a single resource.
6 Conclusion

I believe it is possible to put a value on damage, health and special abilities on units in an RTS game for the purpose of game balancing. However, I do feel that the subject needs to be approached carefully as doing an analysis this way only takes into consideration the properties of the units in the game. It does not take into consideration other important factors of a RTS game like level design. Another example of why this subject needs to be approached carefully is the cost/DPS of the Zergling. Looking purely at statistics using the methodology in this report, a pair of Zerglings would need to cost 346 resources in order to be considered statistically balanced, which 296 more than they currently cost.

I do believe that further research about similar topics is possible as long as they are approached with caution. I do also believe that further research on similar topics might be able to find better methodologies to approach these issues, a not just with RTS games, but with other kinds of strategy games as well. But once again, caution is needed when trying to approach these subjects.
References

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Appendices

Appendix A: About AppendixA.xlsx

This Appendix explains how to read the data in the attached AppendixA.xlsx document. The Excel document includes the properties of each individual unit in the respective games (Save for the Brood Lord and Carrier in StarCraft II, see section 3.1.2 for further information about this).


The data on row 72 and below is just for aid in other calculations. The units with a green background are Protoss units. Units with a blue background are Terran units. Units with a red background are Zerg units.

How to read the data in certain columns:

Column K:
1: Ground unit
2: Tall ground unit (Counts as a ground unit but it can also be attacked by units that can attack air units)
3: Air unit

Column L:
1: Ground units
2: Air units
3: Both ground and air units