POWER CREEP AND THE COLLAPSE OF THE ROMAN REPUBLIC: USING MATH AS AN INTERDISCIPLINARY LENS TO UNDERSTAND HISTORY

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In this paper I will demonstrate the applicability of a certain software program in the math classroom as well as in the history classroom. Rather than working through math programs such as *Mathematica*, *Matlab*, or *Sketchpad*, we will be briefly looking at the video game, *Hearthstone*. Created by Blizzard, the studio behind the *Starcraft* and *World of Warcraft* series, *Hearthstone* has become one of the most popular games since its launch in 2014. The game boasts over 70 million players and remains in the top five most viewed games worldwide in terms of both streaming and eSports.[1] The effectiveness and utility of video games in the university classroom has been firmly established by scholars.[2] Yet, little scholarship exists on how video games might also work as an interdisciplinary bridge between subjects that are often mistakenly seen as disparate - in this case mathematics and history. This paper argues that video games such as *Hearthstone* can be used to not only help students better understand these individual disciplines, but that they can also be to show students the importance and the benefit of cross-discipline discussion.

Hearthstone is an online Trading Card Game, a gaming genre made famous by *Magic the Gathering* first introduced in 1993. In the simplest terms, *Hearthstone* is a 1v1 game in which both players use uniquely-crafted decks of 30 cards to battle one another. By playing minion and spell cards, players attempt to deal damage to opposing players and reduce their total life down to zero. The pacing of the game is determined by a currency known as Mana. Each turn, players have one additional point of maximum Mana to spend

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[1] Statistics on streaming and viewership numbers from Twitch recorded on www.twitchmetrics.net.

[2] James Paul Gee, *What Video Games Have to Teach Us about Learning and Literacy* (New York: Palgrave Macmillan, 2003); Kurt Squire, "Replaying History: Learning World History through Playing *Civilization III*," (Indiana University, 2004); David Williamson Shaffer, *How Computer Games Help Children Learn* (New York: Palgrave Macmillan, 2006); Stephen Johnson, *Everything Bad is Good for You: How Popular Culture is Making Us Smarter* (Harmondsworth: Penguin, 2006); Harry J. Brown, *Video Games and Education* (Armonk, NY: M.E. Sharpe, 2008); Andrew McMichael, "PC Games and the Teaching of History," *The History Teacher* 40, no 2 (2007): 203-218; Matthew Wilhelm Kapell and Andrew B.R. Elliott, eds., *Playing with the Past: Digital Games and the Simulation of History* (New York: Bloomsbury, 2013); A. Martin Wainwright, "Teaching Historical Theory through Video Games," *The History Teacher* 47, no 4 (2014): 579-612;

on their cards. So, for example, on turn four a player could spend up to four points of Mana and on the following turn she could spent up to five Mana points, regardless of what was played on the previous turn. In general, minions that cost more Mana to play are more powerful in terms of their attack and health values. For example, River Crocolisk (figure 1) costs 2 Mana to play, and has an attack of 2 and a health of 3.[3] The ideal situation for players is to be able to play a 2 Mana-cost card on turn two, a 3 Mana-cost card on turn three, and so on, thereby making the most efficient use of the Mana available to them each turn and putting the most powerful minions possible onto the board - what is known as "playing on curve."

Figure 1. Mana Costs and Card Values

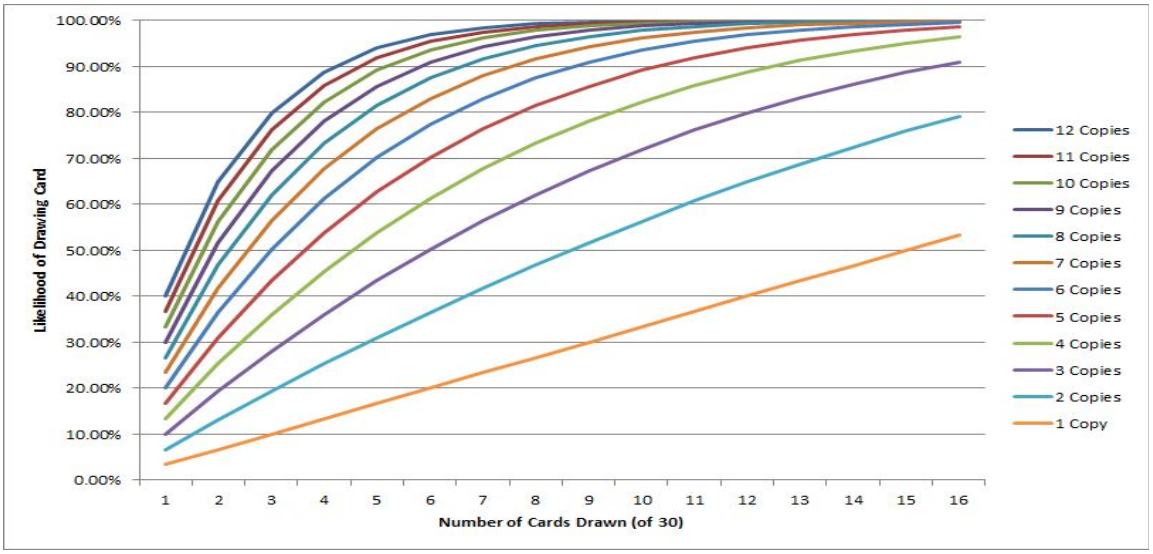
Players, then, must be careful in constructing their decks to ensure that they are not stuck holding unplayable high Mana-cost cards at the start of the game or ineffective low Mana-cost cards at the end of the game. Proper balance and distribution are key. This serves as a good lesson in probability and Hypergeometric Dispersion for students if brought into the math classroom. Indeed, Blizzard encourages players to think in these terms when constructing their decks by highlighting a tracking feature for the Mana-cost of the cards within decks - known as the "Mana Curve" (figure 2).[4]

[3] All card images throughout this paper belong to Blizzard Studios.
[4] Gameplay photo property of Blizzard Studios.

Figure 2. Mana Curve

Thus, Hearthstone players are encouraged to think with probability and disposition in mind when striving to build decks with an effective distribution of low-, medium-, and high-Mana cost cards. Classroom activities to this effect are boundless. Students can be asked, for example, to determine the likelihood of drawing a certain Mana-cost card over so many draws to determine how well players will be able to "play on curve" with any given deck - a question that many of students who play Trading Card Games have likely already asked themselves, unaware of its educational value (figure 3).[5]

Figure 3. Hearthstone Card Draw Probability



[5] All graphs in this paper are my own.

In terms of statistics, students in class can also be asked to determine the relative value of certain cards in the game - something that both players and developers have spent thousands of hours attempting to do. Despite a wide variance of cards in terms of stats, archetypes, and abilities, the statistics behind the power of hearthstone cards is at its core descriptive in nature. Yet some values are more difficult to quantify than others. Many cards, while having clear values in terms of attack, health, and mana-cost, contain additional special abilities that add or detract from the power of the card. Such positive abilities might include "charge," allowing a minion to attack on the same turn it is played; the ability to draw additional cards; or "taunt," which forces enemy minions to attack this creature before anything else (figure 4).

Figure 4. Special Card Traits

What value to assign such abilities can be difficult to determine, although not impossible. Further complicating a statistical analysis of *Hearthstone* is the fact that some minions and spells have random abilities - a statistical factor that developers term the "Delta of Randomness." Based on the result of random outcomes such as damaging random enemies, taking control of random enemy minions, or discarding random cards, the value of such cards operates as a range (figure 5).

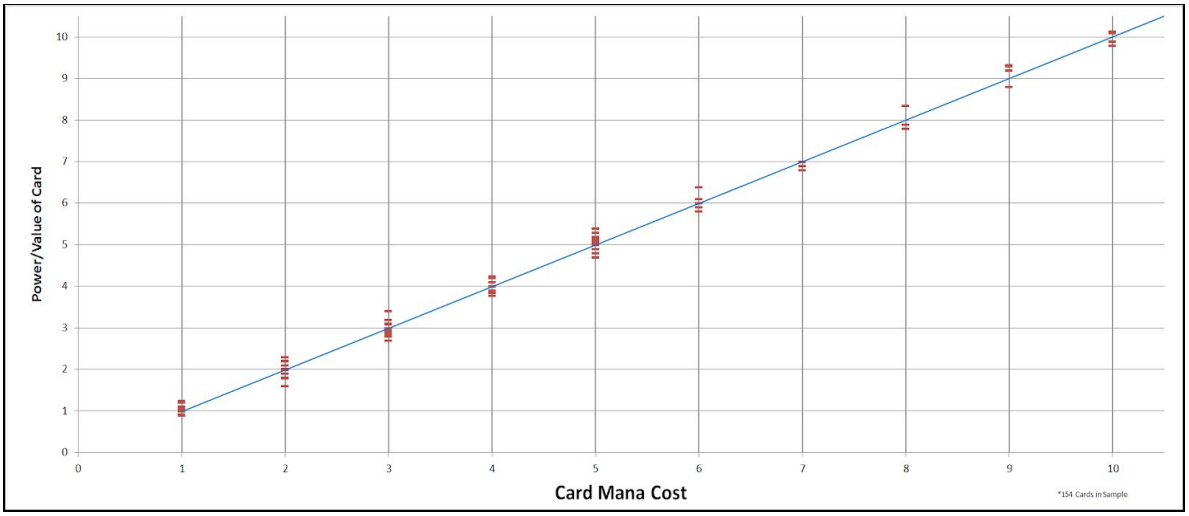
Figure 5. Delta of Randomness

For players and developers of *Hearthstone* and other Trading Card Games, as well as other games such as Massively Multiplayer Online Role Playing Games (MMORPGs), the best answer to this struggle to quantify the relative value of cards is the "Power Curve."

Although ideally not a curve at all, the Power Curve represents the expected power of a card given its Mana costs. In other words, between the attack, health, and abilities of a five cost card, players should expect to get around 5 Mana worth of value, constituting the central tendency of the Power Curve. Such a cost-value analysis should be familiar to students and teachers outside of video games as well. We constantly derive cost based on its inherent value statistic, whether it be through appraising houses, consulting Kelly Blue Book, or tracking stock prices. With Hearthstone, however, rather than determining cost based on value, players must determine value based on cost. As this graph of *Hearthstone* cards shows (figure 6), not all cards in a set will be perfectly on the Power Curve. Some cards will be stronger and be above the curve, and other cards will be weaker and be below the curve. Yet all of the cards for the game should be at least *close* to the curve.[6]

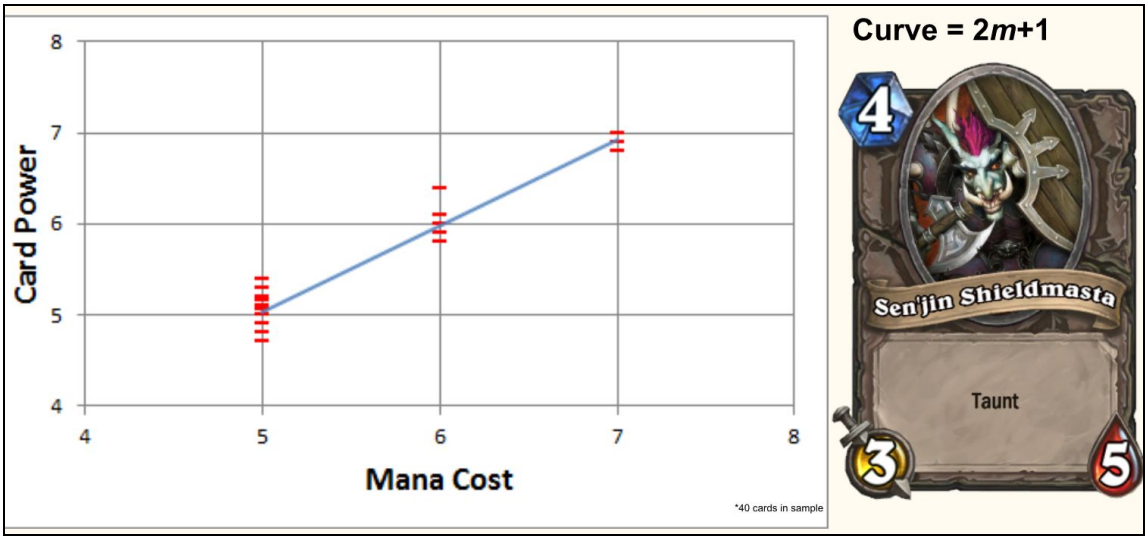
Figure 6. Hearthstone Power Curve - from the game's basic and classic sets

[6] The values of this graph correspond to the strength of the cards from the Basic and Classic card sets that came out upon release of the game in 2014.



While this card value is relative to all of the cards in the data set, it remains fairly predictable for Hearthstone. To be on curve, a card's attack, health, and abilities should add up to double the mana-cost plus 1. A four Mana-cost card on curve, then, should have around eight combined health and attack and some other ability to further increase its value. Our example of Sen'jin meets this criterium as he has 3 attack and 5 health, totalling 8, as well as the "taunt" ability. For its cost, Sen'jin is about where it should be on the Power Curve (figure 7). However, as our graph of the Hearthstone Power Curve shows, not every card is as close to the central tendency as Sen'jin. This variance can be created intentionally by game developers, as part of a phenomenon known as "Perfect Imbalance."

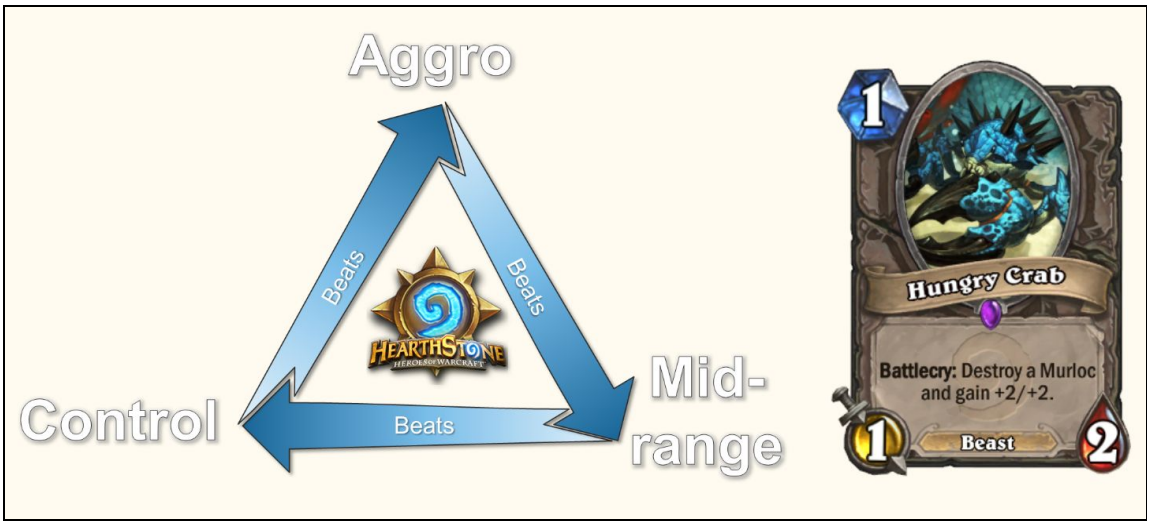
Figure 7. Determining Power Curve



By creating a small amount of imbalance within the game, developers allow players to take advantage of cards that have a slight edge in terms of inherent value. This in turn

prompts other players to build decks meant to counter these advantageous cards. The cycle continues. Unlike in a symmetrical and strategically stagnant game like chess, the strategies utilized at the micro level of Hearthstone are constantly in flux - a process known as “Meta-Gaming.” A card such as Hungry Crab, for instance, which would not normally see much play would suddenly become more powerful in the Meta (although not on the Power Curve in its own right) if a large number of players began playing Murloc-themed decks (figure 8).

Figure 8. Meta-Gaming

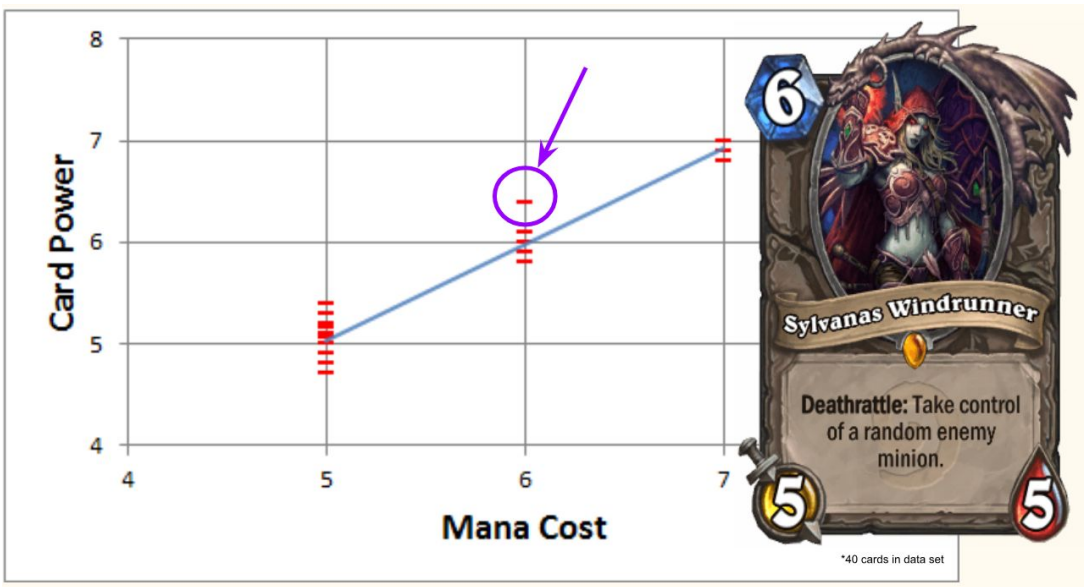


Cards of moderate or lesser value can also see action by building decks that have synergy or combinations across multiple cards, allowing for statistically weaker cards to gain more value. For example, Acidic Swamp Ooze (figure 9) is statistically better than Bloodfang Raptor (figure 9) as it has a strong ability in addition to equal stats and Mana-cost. Despite this, players might opt to use Bloodfen Raptor in their deck over Acidic Swamp Ooze if they were building a deck with Beast synergy. Some spells and abilities such as Command Kill (figure 9) grow more powerful if Beasts are present in the deck. Ultimately, this emphasis on Perfect Imbalance allows for constantly adapting strategies and shifting card values within the Meta without the need for artificial prodding from game developers.

Figure 9. Deck Synergy

While slight unbalance is healthy for such games, if a card is *too far* under-curve, it risks being so weak that it will never see play as no strategy or synergy can justify its appearance over other cards. While this is bad for both the game and the players, it is far worse when a card floats too far *above* the Power Curve. This is known as Power Creep (figure 10). If a card is exceptionally powerful, it threatens to break the careful balance - or rather imbalance - of the Power Curve for that Mana-cost bin. For example, if Sylvanus Windrunner is too far above the 6-Mana Power Curve, the question becomes, "why would you play anything other than Sylvanus in your deck?" At some point the card's value surpasses any possible value gained from deck synergy by other same-mana-cost cards. When there is no longer viable competition between cards, Power Creep has set in and the card has moved from unbalanced to overpowered or broken.

Figure 10. Power Creep



Given the nature of video game marketing, Power Creep often appears when new expansions are released. Sometimes this occurs intentionally to sell the newest set of cards. If a new set of cards is more powerful than the old cards, players will have to buy them to stay competitive. Such marketing, however, tends to backfire as players no longer have the investment that keeps them playing the game. More often, Power Creep occurs *unintentionally*. Despite play-testing, in trying to create new abilities and fresh deck synergies, developers may not realize the power or full potential of some cards until after release. Similarly, unanticipated new combinations can appear with older cards that were considered under curve - and thus not on the developers' radar as potential Power Creep offenders.

A good example of this is Dreadsteed and Defile (figure 11). An older card with mediocre stats, the Dreadsteed's ability states that every time it dies, a new one comes onto the field. This slightly under-curve card suddenly became overpowered with the release of a new spell called Defile. This spell deals 1 damage to every creature in play; if a creature dies then it activates again; so on and so forth. When paired with the Dreadsteed, however, the defile is able to activate without end, as each time Defile damages the Dreadsteed it returns to life only to be Defiled again and again. In other words, the Dreadsteel allowed Defile to clear the entire board for only 2 mana - an unintended and overpowered combination by the developers.

Figure 11. Unforseen Combinations

If a game is to remain balanced and playable, these issues of Power Creep have to be handled carefully. As has been seen with instances of intentional Power Creep through card expansions, players feel betrayed and disenfranchised when their older cards suddenly become underpowered and worthless. The whole premise of a trading card game, after all, is that players can build up their collections and that these cards will remain playable and balanced. Breaking this tacit agreement by issuing new sets of cards that force players to "Pay to Win" inevitably results in the widespread abandonment of the game.

Developers often address unintentional Power Creep in one of two ways. The first method is to alter the card or cards in question in order to bring them back down towards the central tendency of the Power Curve - a process unaffectionately referred to a "Nerfing." In other words, the *dangerous* weapon has to be replaced with a harmless *Nerf* weapon. Developers try to avoid doing this if possible. Studios do not enjoy admitting their mistakes and players do not enjoy getting their shiny new toys taken away, and for physical Trading Card Games, such a move is virtually impossible. The second method of reducing Power Creep is to create new cards that are more in line with the powerful card, thereby taking away its exceptional value relative to the other cards of that Mana-cost. However, the ultimate effect of such a move is predictable: as the Power Curve rises for the 6 Mana-slot, it will have to rise for the other Mana-Slots as well, pulling the entire curve upward. As discussed above, this approach can upset players if older cards then drop so far under the new Power Curve that they are no longer viable. The game ultimately becomes unrecognizable to veteran players.

While there is no lack of ways to utilize such a statistical value study in the mathematics classroom, we will now use this understanding of Power Creep as a lens through which to examine the collapse of the Roman Republic - bringing math with us into the history classroom. For any Trading Card Game or MMORPG, Power Creep, and the statistics

behind it, threatens the long-term stability and success of the game. The ultimate internal collapse of the Roman Republic can be seen in similar terms. The Roman Republic, which managed to gain control over the entire Mediterranean world in a brief period of 51 years between 218 and 167 BC,[7] owed its internal stability to the carefully constructed Republican constitution - described by the Greek Historian Polybius as a careful balance of the people of Roman, the aristocratic Roman Senate, and the two annually elected Roman consuls (book vi). While this mixed constitution had not been without occasional adjustment, the system had remained stable and guaranteed that no single individual would be able to gain too much power and threaten the State. When a Roman statesman wanted to pass a law or take some action, he went before his fellow Senators and the matter would be discussed and voted on. If the Senate was in favor, the decision would then be voted on by the Roman people who held the ultimate legal authority to pass or change laws. Under the Early and Middle Republic, however, the Roman people acquiesced to the wisdom of the Senate in their votes. The People's willingness to bow to the wishes of the Senate, was not dictated by any law, but rather by tradition (*mas maiorum*) which was ultimately more important to the Romans. Thus, no individual in Rome could ever rise too far above the Power Curve, for he would be checked by the Senate.[8]

This balanced system began to crack in 133 BC, however, when a young ambitious politician, Tiberius Sempronius Gracchus, chose to take a land reform bill directly to the Roman People without ever consulting the Roman Senate.[9] An individual suddenly threatened to exceed the influence of the Senate, and the first serious instance of Power Creep reared its head in Rome. And Tiberius' law was in fact passed by the Roman People. The next year, Tiberius' decision to run again for the position of tribune, which tradition dictated could not be held in subsequent years, forced the Senate to act in order to contain the situation. With no legal authority to oppose Tiberius, the Senate resorted to violence, ultimately murdering Tiberius and his followers - the first act of political violence within the city of Rome in almost 500 years. Despite Tiberius' death, dangerous precedents had been set, permanently rising the upper bounds of how high an ambitious individual could reach on the Power Curve. And the situation could not be "Nerfed." The Roman people would not relinquish this newly realized power of the vote, and internal checks on individual power that relied on Roman tradition became increasingly ignored - a fact caused by the Senate's unprecedented use of violence as much as Tiberius' breaks with tradition. Instead, the Senate tried to increase its own power to match the shifting Power Curve so that individual actions could continue to be checked. This came in the

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[7] All subsequent dates are assumed to be BC.

[8] There are a few small exceptions to this, such as Flaminius' land reform bill that was passed in 232 BC by the populace against senatorial wishes, as well as the elevation of Minucius to co-dictator in 217 BC. These examples, however, a certainly exceptions to the rule during this period.

[9] H.H. Scullard, *From the Gracchi to Nero: A History of Rome from 133 BC to 68 AD, 5th ed.* (London: Routledge, 1982); Christopher Mackay, *The Breakdown of the Roman Republic* (Cambridge University Press, 2009).

form of the extralegal *Senatus Consultum Ultimum*, which allowed the Senate to temporarily act without the approval of the Roman People if the safety of the state was at risk - an arbitrary declaration used only a few years later in 121 when the Senate murdered Gaius Sempronius Gracchus, Tiberius' equally ambition brother, under similar circumstances.[10]

Despite this new political tool, the Senate could neither check nor match the rising power of the individual as the Power Curve continued to climb over the next 80 years. During this time, the direct vote of the Roman People unraveled any sense of balance held by the Senate, as the People voted against Senatorial wishes, elected individual like Julius Caesar and Gnaeus Pompey to lengthy commands, exiled competent politicians, and ignored laws that had been put into place to protect the Republic from herself. In 107 an ongoing set of military reforms finalized under Gaius Marius further elevated the Power Curve by professionalizing the Roman army. Such reforms were no doubt necessary for Rome's sprawling empire. Given the wide amount of territory Rome now secured, the traditional citizen-soldier army no longer made practical sense. Despite their utility, however, these Marian Reforms were ultimately damning to the stability of the state. While the former land-owning citizen-soldiers were loyal to the Republic, these new property-less legionaries worked for pay rather than duty, meaning that the Roman general in the field now commanded the loyalty of the troops.[11] And indeed, within 30 years Roman troops had already marched on Rome multiple times in support of their general, Lucius Cornelius Sulla. And soon more traditions broke down at the bidding of the Roman voters. Traditionally, and legally, consuls had to wait ten years between consulships. However, Gaius Marius served as consul for five successive years between 104-100 BC. Later, Sulla named himself dictator for a year in 81 BC. Roman commanders were also increasingly permitted to conduct military campaign for extended periods of time as we see with Pompey in Spain and the East and with Caesar in Gaul. The Power Curve continued to rise.[12]

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[10] T. M. Mitchell, "Cicero and the *Senatus Consultum Ultimum*," *Historia 20* (1971): 47-61.

[11] This is the classic interpretation of the effects of the Marian Reforms: Ernst Badian, "Lucius Sulla: The Deadly Reformer (Sydney University Press, 1970). For the view that it was the actions under Sulla, not Marius, that actually damned the Republic, see Arthur Keaveney, *The Army in the Roman Revolution* (London: Routledge, 2007).

[12] This notion of a systemic shift beginning in 133 goes against the wishes by some scholars to place the fall of the Republic as only totally reliance upon the individual and events of 49. See Eric Gruen, *The Last Generation of the Roman Republic* (University of California, 1974); as well as Niall Ferguson, "Complexity and Collapse: Empires on the Edge of Chaos," *Foreign Affairs* 89 (2010): 18-32. Arguments a more gradual decline of the Republic, though not in terms of Power Creep, have been made by Badian (1970); M.H. Crawford, "Hamlet without the Prince," *JRS 66* (1976): 214-217; Scullard (1982); Crawford, "Italy and Rome from Sulla to Augustus" in Bowman ed., *The Augustan Era* (University of Cambridge, 1996): 414-433; Keaveney (2007); Mackay (2009); Martin Jehne, "Did Caesar Destroy the Republic? Once again the Great Man and History," (McGill University, 2014).

Further Power Creep can be seen in unanticipated political combinations at work. For example, it was Roman law that those with *imperium* - the higher command held by Roman consuls and praetors - could not be prosecuted for crime. It was only after they had stepped down from their annual term in office that legal indictment could be attempted. This law was still in effect in 59 B.C. when Julius Caesar was elected to his first consulship. During his term, Caesar used physical violence against his co-consul, a clear violation of Roman law. Before his term in office ended, however, Caesar was given command of the governorship of Gaul, giving him fresh *imperium* and continuing his immunity from prosecution. This governorship stretched from 58 all the way to the beginning of 49 when Caesar was planning to run for his second consulship. Thus, if elected in 49, Caesar would continue to hold *imperium*, protecting him from the crimes he committed as consul ten years earlier.[13] This unforeseeable combination was only possible due to the acceptability of such lengthy commands under the new Power Curve - a notion that Romans of the Early and Middle Republic would have found aprehensible.[14]

The fact that Power Creep was occuring within the Republic was not missed by the Romans themselves. Sulla, Pompey, and other statesmen attempted to repair the situation by Nerfing the maximum power-potential of individuals - limiting command length, curbing bribery, and placing gaps between term of command. Such attempts, however, were ultimately in vain.[15] The Power Curve had already risen beyond repair. Thus, in January of 49 BC, moved by illegal actions taken by the Senate as well as his own ambition, Julius Caesar marched on Rome with a loyal army at his back that had fought with him through Gaul for the past eight years.[16] The violence begun by the Senate in 133 against Tiberius now found its climax in the period of civil war that engulfed Rome for the next 19 years. The Roman Republic, with its once carefully balanced Power Curve, had now become unrecognizable. The power of individuals like Marius, Sulla, Pompey, and Caesar became too much for the Roman constitution to remain in balance despite its best efforts. Thus, as all game designers fear, it was ultimately Power Creep that broke the Roman Republic from within.

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[13] Greg Stanton, "Why did Caesar Cross the Rubicon," *Historia 52* (2003): 67-94. For the view that fear of prosecution did not affect Caesar's decision in 49 BC, see: Robert Morstein-Marx, "Caesar's Alleged Fear of Prosecution and his *Ratio Absentis* in the Approach to the Civil War," *Historia 56* (2007): 159-178. Also Gruen (1974).

[14] While there were extraordinary commands at times during the Republic — Camillus was dictator five times, Papirius Cursor was consul five times and dictator twice, M. Valerius Maximus Corvus was consul five times and dictator once, Q. Fabius Maximus Rullianus was consul five times and dictator once, Q. Fabius Maximus Cunctator was consul five times and dictator twice, and Scipio Africanus fought in Spain and Africa under his own authority for most of 211-201 — both the moderation as well as the expectation of such command was quite difference under the late Republic, despite Gruen (1974).

[15] Badian (1970); Scullard (1982); Keaveney (2007); Mackay (2009).

[16] Stanton (2003); Morstein-Marx (2007).