MOFPS game development history, status, and future predictions

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Abstract

The article sorts out the history of FPS games including e-sports and live broadcasting, analyses and predicts the trends of current popular game engines. The article also analyses game development from multiple angles. The suggestions given include: updating the game engine can help improve the depth of the game, game updates should follow the principles of software engineering, developers should try to proactively end the game imbalance problem, and game engine optimization is important, which requires more efforts.

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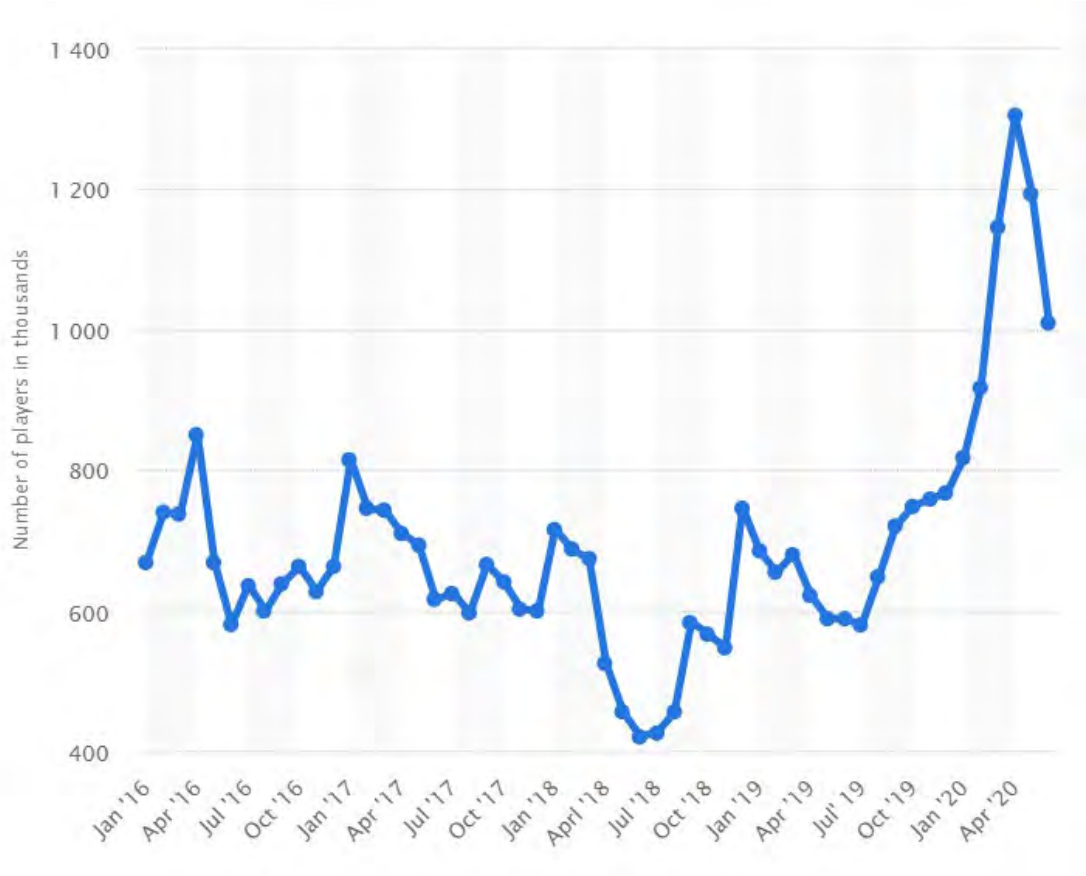
1 Introduction

This year will be destined to be a special year. The world is experiencing unprecedented changes and challenges due to the coronavirus. For the gaming industry, 2020 will also be a milestone year. As a way of entertainment, social interaction and stress release, games play a key role in society. Affected by the pandemic epidemic in 2020, more people are trapped at home. Games have helped improve people’s quality of life. Naturally, sales have increased significantly (Schreier,2020) (Newzoo, 2020).

The total sales of video game hardware and software in the United States reached US$6.6 billion, the highest level since 2010 (Gartenberg, 2020). The Asia-Pacific market will create $78.4 billion in revenue in 2020, a year-on-year increase of 9.3%, accounting for almost half of global game revenue. Nintendo's new game *Ring Fit Adventure* was once sold out, and it was even difficult to buy spot goods at prices several times the original price (Sarkar, 2020). Shooting games, as the third major category of game segmentation, are played by 47% of players (ESA, 2019). The famous FPS game *Counter Strike: Global Offensive* also ushered in its biggest monthly increase (27.8%) since its release in April 2020, and also created the highest number of online games in the game. The number of games played in August was almost 2 times the same period last year (Steam Charts, 2020).



Monthly number of peak concurrent players of Counter-Strike: Global Offensive (CS: GO) on Steam worldwide as of June 2020

Source: Statista

FPS games, at least to a certain extent, help enhance attention-related cognitive ability (Spence & Feng, 2010; Dye, Green, & Bavelier, 2009a; Feng et al., 2007; Green & Bavelier, 2003; SEYA & SHINODA, 2016). In this context, game development, as a long-neglected part of the domestic computer field, has attracted my attention. Combined with my personal preferences, the following research topics have been determined. This article hopes to sort out the development history of the FPS game industry, analyse the impact of FPS game content on game development and the trend of future game development from the perspective of a software engineer.

2 History of FPS games

This part will give some introduction to the history of FPS games, and at the end will introduce the development of e-sports in multiplayer online games and the impact of the live broadcast industry on the game industry.

2.1 Short history of first-person shooter game

When it comes to the origin of FPS games, an arcade game Battle Zone (1980) developed by Atari has to be mentioned. In his 2012 book *Guns, Grenades, and Grunts: First-Person Shooter Games*, Mark believes that it represents the fusion of FPS type, which brings together the indispensable elements of currently recognized first-person shooter games.

Prior to this, the platform for shooting games has gone through several stages of development, from real guns to arcades, from arcades to home consoles, and then to mainframe. Some game companies have ported arcade games to computers, and now more FPS games run on PC. The representative games of each stage are listed below. Shooting games first appeared in playgrounds. To this day we can still see shooting games in playgrounds. Around 1970, shooting games began to appear in home electronic game consoles. Magnavox Odyssey (1972) is the first commercial home electronic game console, using Ralph H. Baer's prototype production, and its advertisement shows an impressive gameplay: twist the two knobs of the controller to control vertically and parallelly of the cursor on the TV screen, you can play not only shooting games, but also other casual games through covering different translucent drawings on the TV screen (Langshaw, 2014; Knowles, 2015).

In 1994, Sega released the 2D first-person shooter *Virtua Cop* on the arcade and ported it to the Windows 1997 operating system the following year. After several years of development, arcade FPS games have become more mature, but obviously the platform of FPS games has been transferred to personal computers. *Wolfenstein 3D*, developed by the famous game development company *id Software* in 1993, is

recognized as the first successful PC game. It is worth mentioning that the company has developed several engines including *Quake*. Afterwards, the engines used in a large number of FPS games are based on the engine developed by *id software*. For example, *the GoldSrc* used by *Half-Life* is a highly customized *Quake* engine, still has some *Quake II* engine code hidden in *the Source* engine even in the new version of Source (Carmack, 2004).

Epic launched *the Unreal Engine* in 1998, *id Software* launched *Quake III* in 1999, *the Source Engine* was first used in Valve's *Half-Life 2* in 2004, and the Unity Technologies released Unity 1.0 in 2005. version. In another part of the article will introduce theses famous game engines in detail.

In addition to engines, the FPS gameplay is also undergoing changes and development. In Craig A. Lindley's point of view, FPS games have three parts: simulation, narrative and game. Simulation, that is, the pursuit of more realistic and reasonable game content, has always been the pursuit of practitioners, especially in the early days.

Including the setting of the first perspective of the game, the real characteristics of shooting, etc. have experienced a period of development. The first problem in making FPS games is how to do it in the first person. Most games use a fixed camera, that is, the weapon and the camera are relatively fixed, and the centre of the screen, the position where the crosshair is located, is the bullet landing point. In reality That is, when you turn the muzzle, your head also turns at the same amount. In terms of the reality of shooting, many games have been simplified, because shooting in reality is more complicated, and there are many influencing factors, such as the distance of the object, the wind and the movement of the object, air density, humidity, bullet shape, Barrel length, rifling, powder load, barrel warpage, etc..

As the technology matures, FPS games have gradually shifted from single player to multiplayer.

Epic released *Unreal Tournament* in 1999, which was the first first-person shooter game purely for multiplayer games. The single player mode of the game is more like a

training mode. Players can practice their game skills with AI, but the most important thing is online and LAN games (Mullen, 1999). The game was a huge success and inspired others to work on similar works.

Team Fortress was one of the first to try this type of game, which was originally released in 1996. The game allows players to choose one of 9 different categories, each category uses its own weapons, and has different movement speeds, health, etc (Mullen, 2005). Deathmatch games that focused on cooperation rather than "everyone for themselves" immediately became popular. Valve bought the team that made the mod and asked them to work on the half-life engine modification and Team Fortress 2 in 2007. The sequel completes all the elements of the first game and adds a cartoon art style, making them all blend together to become one of the most popular FPS games in the past decade (Francis, 2007).

Overwatch may be the pinnacle of a team shooter for the time being. Heroes with rich details have exciting abilities to interact in various strategically interesting ways. The developer Blizzard did not do much in the FPS field before this game, but they have proven that they have the ability to create exquisite and ingenious products.

From simple to complex, from single to multiple, from single to networking, from LAN to Internet. From 1980 to 2020, the game has experienced 40 years of development and has become a mainstream game type (ESA, 2019).

2.2 eSports and Streaming

22% of PC players spend 61-80% of their time playing multiplayer online games. 48% of PC players spend more than 60% of their time playing multiplayer games. More and more players play online games, and e-sports and live broadcasting have become hot spots now.

Data of Average Time Spent by Gamers in the U.S. Playing Online Multiplayer Games by Device (as of December 2016)

	Home console	Handheld console	PC	Smartphone/tablet	Set-top box
Don't play online-multiplayer	3%	5%	1%	2%	3%
up to 20%	13%	19%	16%	19%	14%
21% - 40%	16%	16%	14%	18%	17%
41% - 60%	22%	25%	21%	20%	21%
61% - 80%	26%	18%	22%	21%	20%
81% - 99%	17%	14%	19%	14%	15%
Play only online-multiplayer	4%	3%	7%	5%	10%

Source: Statista Survey

Created by WePC.com

From the Space Invaders Championship (1980) held by Atari in a big mall to *the League of Legends* Major Tournaments happened in stadiums. eSports developed strongly in the past few decades. In the specifically FPS field, it is hard to not mention *Counter-Strike*, a phenomenal FPS game, which has a long history. Since 2000, *Counter-Strike* has seen almost two decades of competitive play across multiple games, through excellent balance, game engine and good communication with the player community. That competition has been headlined by events called Majors—high profile tournaments hosting the world's top teams. These Majors are also a core element to the game's long lifespan, as each year has seen over six figures in prizes across the various Majors.

In the pre-CSGO period, that is, between 2000 and 2012, many good competitive games emerged. For example, CPL and CGS, although both eventually withdrew from the stage of history, but they have made excellent preparations for the current e-sports

competition.

CPL is a hodgepodge of various games featuring CS from 2000 to 2007. Once CPL was the pinnacle of competitive games. CPL includes more than 300,000 participants, hundreds of international events and more than US$3 million in prize money. Suddenly, the alliance ceased operations in 2008.

CGS is also a classic case of overspending and under planning. CGS and DirecTV were launched in 2007 in cooperation and are expected to become a new era of CS, but CGS was not completed in the end, bringing the rest of the process to a standstill (Lewis, 2015).

CSGO was launched by Valve in 2012 and has since entered a new era of CSGO e-sports. The current CSGO e-sports system consists of competitions and leagues. The tournament is officially supported by Valve, and different leagues allow players to refine their game skills during the tournament. Famous leagues include ESL Pro League, ELEAGUE, FACEIT Pro League, King of Nordic, among others（Mitchell, 2018）.

It is worth noting that, according to Valve's judgment, professional third-party hosts change every year. Every year, the organizers of the tournament will introduce developers to who will host one of the two available professions.

Valve seems to have explored a stable development mode of e-sports competitions, by looking for professional third-party organizations to host the competition and supporting the competition through various means such as funding and supervision in the official name.

Current Major Selection Mode was starting from *ELEAGUE Major: Boston 2018*, Valve announced a new overall tournament format, which brought in the Offline Qualifier as a part of the Major Championship. This new format increased the number of teams at the Major Championships from 16 to 24 and re-named each stage of the tournament into *The New Challengers Stage, The New Legends Stage, The New Champions Stage* (Mira, 2017).

The development of CSGO's e-sports has paved the way for subsequent games.

Subsequent FPS e-sports events, including Overwatch, PUBG, Rainbow Six, and so on, have attracted the attention of a large audience.

Another charm of e-sports needs to be given by the live broadcast platform, which is the special experience of the audience watching the game through the Internet. Just like the people watching at the Colosseum in ancient times, looking forward to the most exciting performances by the best gladiators in the world. Jesse Schell mentioned in the book "The Art of Game Design" that the arena is a public platform where classic games take place. From the perspective of players, the excitement of this competition makes them like this game more. The BR game boom in 2017 also proved this point. At that time, 52% of Chinese players were playing PUBG, the classic BR game; from the audience's point of view, watch the players' excitement from the perspective of God on site or through live broadcasts. The performance is very tempting. Newzoo estimates that by 2022, the number of global e-sports viewers will grow to 645 million. Compared with CS professional games after 2000, players at that time could only wait for game results and videos in the community. The emergence of live broadcasts was disruptive to the development of e-sports games. It is obvious that live streaming can improve the visibility and service life (Johnson & Woodcock, 2019) of games. In addition, live broadcasting, as a form of game commentary, has three-dimensionally shaped the status of the game in the community. Hyper Scape is a game that allows viewers to adapt the progress of the game. The game allows viewers to vote for random events that occur in the game, and the random event with the most votes will occur (Ubisoft, 2020). This is an impressive attempt, and the application of this in e-sports is also expected.

3 Game development

3.1 Game Engine General Introduction and Analysis

The engine usually refers to a platform that coordinates the assembly of various graphics, sound, physics, and artificial intelligence components (Ward, 2008). Game developers can quickly use various functions and their extensions in the game engine. Specifically, it can be used to create a 3D world and visibility management. Excellent visibility management will make the game run more smoothly under the same hardware conditions.

Compared with other software frameworks for software development, in game development, developers use engines as tools and frameworks for making games (Politowskia, Petrillob, Montandonc, Valentec and Guéhéneuca, 2020). At present, the popular FPS games on the market have a trend of self-developed by major manufacturers. Almost all large game manufacturers have their own exclusive engines, Valve’s Source1 and countless modified versions, EA’s Frostbite, Rockstar’s RAGE, and Activision Blizzard’s And IW, Ubisoft's AnvilNext series, Capcom's Panta Rhei, Microsoft's Slipspace and so on. There are commercial elements. Long-term use of other people’s game engines requires permanent engine copyright authorization, and game engine developers may require mandatory sharing in the agreement. At the same time, it can be inferred that different game engines cannot bring game companies. For competitive advantage, the difference between them is not big, there will always be better engines, but at present, the game engine has not yet been revolutionized.

Judging from the development history of the game, it is undeniable that among the many game engines, there are always good ones that stand out. However, there are few revolutionary changes in the technology of game engines. From Source to Unreal, they are all written in C++. In fact, almost all game engines currently launched use C++ as the main programming language. The comprehensiveness and performance of

C++ suitable for game development is one of the unchanging reasons. The more reason I think is that programmers have become accustomed to using C++ to develop game engines. From the earliest 2D line games to the current realistic 3A masterpieces, more is just hardware advancement. After programmers have more usable memory and better computing performance, they naturally produce better paintings. Quality and physical collision system. In recent years, when almost every game is launched, it will claim to have the new best game engine, but no matter from the feedback of players or the complaints of game developers, no game engine has a huge advantage. You know, until 2020, EA's Rebirth Studio is still using the (highly modified) Source Engine for game development and has developed first-line works such as Titanfall and Apex.

In this way, the current engine is not a decisive factor in the unpopularity of a game. But this may not be the truth, maybe it's just because there is no game engine that is truly outstanding. Although I do not expect a game engine that monopolizes the game development industry in the future, I respect the possibility of such a situation.

For the game industry, another strange phenomenon is that almost no open source engine is used in popular games. Of course, it can also be said that almost all popular games are developed by major manufacturers, but the use of Unreal to develop games by small companies like Bluehole can show that even small companies have no desire to use open source engines. Maybe it's because the open source engine is too backward. The last time the id Tech 4 engine was maintained on GitHub was 9 years ago, and it is clearly outdated. It can be seen from this that most game companies also believe that publishing the engine code under development is not a thing to their advantage.

The relationship between game engine development and game development itself is worth exploring. At present, most game manufacturers let game development drive engine development. In the future, due to pressure, some large companies may open source the code of free engines. If they do not encounter a crisis, this will probably not happen. The era of one engine for one manufacturer will continue, because this is

not only a commercial advantage, different engines represent different personalities and gameplay, which is a must-have for a game company. Of course, I do not doubt that the same engine can make a completely different game. Therefore, another reason why a manufacturer has one engine is that after the advent of the next generation of consoles, engine competition will become more intense. Game companies with better engines and more reasonable company organizations will gain an advantage, and there will be more in the future. Professional developers enter the field of game engine development, and game engines will also become part of the competition among game manufacturers.

3.2 Game Engine Examples

In this part, I will analyse several well-known engines in detail.

3.2.1 Source Engine

Source Engine appeared as a Mod of the first batch of excellent engines Quake, and then further developed by Valve to form *Source Engine*. It's one of the most classic and oldest FPS game engines. It has mainly released the following versions:

- Source 2004： The original *Source Engine*, *Half-Life 2: Lost Coast* and early CSS, DODS also used this version (Valve, 2020).
- Source 2006: Shortly released for a while, officially abandoned.
- Source 2007: Half-Life 2 Chapter 2, Team Fortress 2, etc. are used in this version.
- Source 2009: Shortly released for a while, officially abandoned.
- Source 2010\Alien Swarm Branch: The Road to Survival series, Alien Swarm and Portal series all use this version (Valve, 2019). The iconic feature is the main menu that is obviously different from other versions. The plasticity of the shadow is also unexpectedly strong.
- Source 2013: CSGO and Titanfall series used this version (Valve, 2020).
- Source 2: As of 2020, only Dota2 and VR Lab will be used (Kollar, 2015).

There are not many companies that still insist on using Source Engine to make games. These games mainly come from *Valve Company* and *Respawn Entertainment*. *Respawn Entertainment* purchased the copyright of Source in 2014 to make the next games. Because the game style of Titan's Fall is far from that of the CS series, there are arguments that believe that *Respawn Entertainment* has modified the original engine. This happens to prove that the adaptability of *Source Engine* is at another level. There may be two reasons for its high universality. First, *Source* is a relatively primitive, undeveloped engine, so anyone who makes modifications on it can get a completely different engine and game style. Second, *Source* has excellent adaptability and freedom, allowing each producer to highly customize their own game style. Speaking of the game style, although these games have huge differences in image

quality, there are still many imprints of the origin engine. For example, the character will accelerate when rotating, jump acceleration, rich CFG files and so on.
For this engine, there are no particularly obvious common bugs. More bugs are caused by mistakes made by game makers when making maps and other objects, causing objects to collide with an abnormal volume or fall off the map, or unable to obtain items in a certain area. These bugs usually point to programming logic problems. However, it can be guessed that one of the game styles is that the character can do some operations through the character model itself, such as the effect that appears when pushing a box, blocking the door to be opened, and so on. The author of this article believes that in the foreseeable future, in Valve’s games, the new version of Source Engine will serve as a closed private closed source engine to show continued vitality, but the long history of the engine will become a resistance to innovation. It is very difficult for Source Engine to become the first next-generation engine to break the balance of the engine industry; in other games, Source Engine is likely to be abandoned because it has too many free or open source competitors, except for Respawn Entertainment, which was acquired by EA. I do not think anyone else will enjoy the process of making games with the Source engine.

3.2.2 Unreal Engine

Unreal Engine (UE) is a well-known game engine developed by Epic Games, which is controlled by China's Tencent Group, and one of the first publicly available game engines. As the only game engine that can compete with Unity in terms of market share, Unreal Engine has long been ranked among the top three on various lists (CBInsights, 2018; Blake, 2019). Even before the development of the Anvil engine in 2007 and the acquisition of Massive Studio from Activision Blizzard in 2008, Ubisoft used Unreal Engine to produce its own Splinter Cell series of games.
In addition to its high market share, UE has an extremely long history. The first version of Unreal 1 was launched in 1998, and the latest version is Unreal 5, Epic will provide its previews in early 2021 and is expected to be fully launched at the end of

the year. Epic also plans to integrate it into its hottest shooting game Fortnite in the middle of next year. As a comprehensive game engine, Unreal does not only focus on FPS game development, and not many game manufacturers will choose to use Unreal to develop FPS games. Whether it's the *Splinter Cell* series or *PlayerUnknown's Battlegrounds*, the phenomenal MOFPS (Multiplayer Online First-Person Shooting) developed by the Bluehole, includes third-person perspective. It is not a traditional first-person game, and *PlayerUnknown's Battlegrounds* has also been criticized for its optimization problems, various bugs and unprofessional gaming contents. I would like to believe that one of the reasons why Bluehole uses Unreal as a development engine is that it is public, and the rest of the FPS engines are not open to the public. From this point of view, Unreal may not be the most suitable game engine for FPS development, but the popularity of *Valorant* is evidence of Unreal Engine's best adaptability to FPS games. In addition, its comprehensiveness and features open to everyone are still his irreplaceable advantages.

3.2.3 Unity

When it comes to game engines, Unity is undoubtedly should be mentioned. Like Unreal, Unity is not an engine specific for shooting games. It is highly cross-platform and can be used to develop Windows, MacOS, Linux, PS, Xbox, Wii, 3DS, Switch, IOS, Android, HTML5, Games on multiple platforms such as TVs, Oculus Rift, and AR Kit.

Escape from Takov, developed by the *Battlestate Games* studio from Russia, launched the first closed beta in 2016 and is still in the testing stage. In addition, it is difficult to find famous multiplayer online FPS games made with Unity. More of other types of games, such as open world games (*Disco Elysium*), plot games (*Detention*), small games (*Fall Guys: Ultimate Knockout*, *Monument Valley*, *Hearthstone*), mobile games (*Honor of Kings*, *Temple Run*, *Arknights*).

3.2.4 AnvilNext

The AnvilNext2.0 engine from France has shown some potential and instability. As a descendant of AnvilNext, Ubisoft’s best engine, a small number of bugs are frequently found in AnvilNext 2.0. For example, character model stuck in the wall, FPP changes to TPP, and player falls off the map (both in *Tom Clancy’s Rainbow Six: Siege* and *Hyper Scape*. Similar manifestations).

The famous FPS game *Tom Clancy’s Rainbow Six: Siege* (R6) with a large number of outrageous and repetitive bugs was also produced with this engine, which lowered the community's expectations for the future of the engine. The chaotic situation of R6 does not prove that the engine is bad, it is widely believed to be made using *Tom Clancy’s Rainbow Six: Patriot* (Patriot) Code. The Patriot is a game that was cancelled by Ubisoft due to poor quality. The creative director of the game had already resigned because this situation before the cancellation was announced (Crecente, 2014). Later, the developers developed R6 based on this game. However, after consulting the trailer of Patriot, it is obvious that the UI design of this game has some Hyper Scape characteristics. It is a more realistic game that is biased towards plot and authenticity, rather than a multiplayer online FPS competitive game. In simple terms, it's more like Call of Duty than CS: GO.

It is obviously not an easy task to develop a game based on such a completely different game from Siege. This may be one of the reasons why many bugs recurring in Siege, because the code that has nothing to do with the game content is embedded in the game and is difficult to strip. This increases the difficulty of maintaining the game. But this is not an AnvilNext problem. The success of Hyper Scape proves that AnvilNext can be reused.

3.2.5 Frostbite

Since its launch in 2008, the Frostbite Engine has always been the signature engine for FPS games of Electronic Arts (EA) from the US. As an exclusive engine that is not authorized to the outside world, Frostbite is very successful.

Since participating in *Battlefield: Bad Company* as Frostbite 1.0 in 2008, Frostbite has

been the best choice for EA's FPS games. However, in the strict sense, Frostbite 1.0 was used solely for this work, because it quickly evolved into Frostbite 1.5. This stage of Frostbite has passed *Battlefield 1943* and *Battlefield: Bad Company 2* and has been used by many Domestic players know that the biggest feature of Frostbite 1.5 at this time is that the destruction effect has reached the point where it keeps pace with imagination. At the 2011 E3 Game Show, EA DICE showed the fully integrated Frostbite 2.0 and the latest *Battlefield 3*. Frostbite 2 which fully supports DX11 not only surpassed its opponents on the screen, but also established a unique DICE sound effect. In addition to some of the leading advantages, there is even an animation motion capture system that is unique in the industry, making the characters' movements appear natural and real.

In addition to *Battlefield* and *Medal of Honor*, Frostbite has also revealed its own characteristics in many games. For example, in *Mirror's Edge Catalyst* and *Lucidity*, Frostbite has adapted to different games. The adaptability of the style continues the bright, pure, and clean picture style in the former. The light and shadow reflection quality that Frostbite is proud of is reflected. When it appears in a horizontal 2.5D game, it can look beautiful, bright, and splendid, and it seems like a fairy tale. The Frostbite Engine is actually a development tool developed by EA and internally digested. It has never been authorized and opened to the outside world. This is actually an important strategic advantage. Because it is a big EA and has developed a lot of games, the Frostbite is actually an internal one. A large group of people continue to try and optimize and continue to contribute code in terms of time and quantity. This makes developers increasingly familiar with this unique tool.

In fact, except for the case in *Battlefield 4*, which was released due to rush and had many bugs, many tools developed by Frostbite Engine did not have serious quality problems also illustrates this point.

This article predicts that in the short-term future, Unreal Engine will still be the best open game engine, Source Engine has fallen behind the times, and Frostbite and AnvilNext will perform stably in the future. Of course, here are some compliments to

the employees of *Respawn Entertainment* who insist on optimizing the Source Engine.

3.3 Game Content

3.3.1 The depth and creativity of the game's learning content

It is not easy to objectively evaluate the learnable depth and creativity of the game. There is a relatively simple way to check the game duration of professional players, but there is also a problem. The problem is that if the game is released much earlier, naturally players will have more time to play this game, so when analysing the depth and creativity of each game, this article will try to find those players who have less playing time in well-known teams, so that I can compare each game as fairly as possible.

Different game types and styles will also affect the cost of learning. Because some games are fast-paced, players do not need to spend too much energy on the details, and slower-paced games usually determine success or failure in details. There are always some same parts in different games needed players to learn, such as movements, gunfights, utilities, strategies, special angles/spots, team coordination, etc.

In addition, research has pointed out that it is more difficult for beginners to perceive visual information compared to terrain information, and they also have a more positive reaction to the enemy they saw on screen (Choi & Kim, 2016). On the other hand, it seems that a skilled player plays the game by considering his experience, perceived information. Beginners focus on simple, goal-oriented gameplay like fight with enemies. Experts seem to be able to actively reconstruct their own unique entertainment elements by analysing terrain information and the enemy’s location, thus focusing on complex gameplays. Skilled players and new players have different visual processing methods, and there is a big gap in visual analysis capabilities. This shows the vastness of the learning content of the game, not only static knowledge needs to be understood, but more dynamic experience and reaction (Choi & Kim,

2016).

This part will evaluate for *CS: GO*, *Tom Clancy's Rainbow Six: Siege*, *Apex Legends*. Since the remaining games do not have a mature e-sports system, we will only do a simple analysis. It is important to note that although the author adheres to the objective, fair and scientific statistical point of view to analyse, due to lack of experience and limited ability, the analysis in this part may still be preliminary and subjective.

CS: GO

The engine CS: GO used has a lot of similar content that can be learned. These contents have decent depth, but they have been exhausted. The creativity showed only in the different spots of the utilities. CS: GO is a game easy to play but difficult to master, skills and strategies need a lot of practices. When people do not interest in game see players playing CS: GO always have thousands of hours of game time, which is difficult to understand, but this also proves that the depth of CSGO learning content is impressive. From another perspective, if you understand a game to a sports competition, then its depth is not limited to the game itself. The player's mentality, experience, personality and other very important parts of traditional sports have also become the learning content of this game. Obviously, CSGO is one of the most suitable games for e-sports competitions, which is undoubtedly a plus for its depth of game.

In 2017, Jakvah counted the CSGO playing time data of a group of professional players on Steam. This article tabulates the final statistics as follows.

Team	ID	In-game Hours
Astralis	Xyp9x	5,210
	Dupreeh	5,983
	gla1ve	5,073
	device	5,462
OpTic Gaming	NAF	5,137

	Tarik	7,516
SK Gaming	fox	4,780
	Fallen	7,332
	Coldzera	6,239
	Taco	6,451
	fer	5,011
Ninjas in Pyjamas	GeT_RiGhT	5,948
Virtus Pro	Snax	5,458
	byali	6,617
	pashaBiceps	6,023
	Neo	5,841
	TaZ	6,709
North	RUBINO	7,236
	MSL	5,684
	Magisk	3,982
	k0nfig	5,390
FaZe	allu	5,622
	kioshima	5,001
	rain	5,337
	aizy	7,276
	Karrigan	6,008
Fnatic	olofmeister	5,348
EnVyUs	SIXER	5,444
	kennyS	5,902
	apEX	7,456
	NBK	5,847
	Happy	5,544
Cloud 9	n0thing	6,611
	Skadoodle	6,094

	shroud	6,899
	autimatic	4,982
	Stewie2K	6,911
NaVi	s1mple	9,450
	Guardian	6,523
	flamie	5,289
	seized	7,338
G2	shox	5,312
	bodyy	5,597
	RpK	3,618
GODSENT	JW	6,512
	flusha	6,601
	Lekr0	7,054
	znajder	7,159
Team Liquid	Hiko	6,678
	nitr0	6,028
mousesports	Niko	4,822
	ChrisJ	7,677
	Iowel	5,380
	denis	6,228
	spiidi	5,842

One of the more convincing is Rpk's 3618 hours of game time. He is a well-known player and has less game time than his peers. *Counter-Strike* was officially released in 2012. Five years have passed since 2017 as recorded by the statistics. This may be a bit unfair for other new games, and we will pay attention to this in subsequent evaluations. CS: GO defines the most classic multiplayer competitive fps learning content. In this single item, this article will define CS: GO as the average level.

Apex Legends

Compared with CSGO, the innovation of Apex Legends mainly lies in the game content and details. In fact, it is easy to classify Apex as a CSGO mechanical core (engine), PUBG battle royal game mechanism, OW game content (character skills), and Titanfall worldview Fusion games. Only some minor changes were added, such as the Ping system and the Respawn system. This may seem a little lack of innovation, but Apex is considered by multiple articles to be one of the best battles royal games (Livingston & Park, 2020). The reason is simple. These small game contents give players a more user-friendly gameplay, giving players who are tortured by PUBG and other battle royal games better choices. At the same time, it is based on the fall of the Titans, which makes its world view is also relatively perfect.

Apex has movement skills including several jumping skills. Due to different legends choices, players can create different line-ups to perform different tactics and skill combos, which is very pleasant. Its game depth is not as good as CSGO in terms of pure posture, marksmanship, throwing objects and tactics. Because of the large map, players have limited motivation to pursue perfection in every detail, but it allows players to learn more in terms of game mechanics. Each of its skills obviously serves the game and makes the game better. This is what should be expected.

Method

Since Apex Legends does not have complete game duration statistics, I have collected the game data of Twitch streamer ‘FunFps’, recorded his game content for more than 20 hours, combined with Apex’s own experience system, and formed a method for estimating game duration. I used this system on accounts with known game duration, and the error of the results is about 5%, and the game duration is overestimated.

Apex Legends experience system is shown in this chart below, after level 58, players need 18000XP to reach next level, and the max level is 500 in season 6. Although the max level is 500, Apex Legends still counts players XP after they reached 500 level, and when players reach another 18000XP, game will still display ‘level up!’ content on the screen.

Level	XP to reach next level	Δ XP
1	100	N/A
2	2650	+ 2550
3	3900	+ 1250
4	4750	+ 850
5	5600	+ 850
6	6350	+ 750
7	7100	+ 750
8	7850	+ 750
9	8150	+ 300
10	8600	+ 450
11	9050	+ 450
12	9500	+ 450
13	9950	+ 450
14	10400	+ 450
15	10850	+ 450

Level	XP to reach next level	Δ XP
16	11300	+ 450
17	11750	+ 450
18	12200	+ 450
19	12350	+ 150
20	12500	+ 150
21	12650	+ 150
22	12800	+ 150
23	12950	+ 150
24	13100	+ 150
25	13250	+ 150
26	13400	+ 150
27	13550	+ 150
28	13700	+ 150
29	13850	+ 150
30	14000	+ 150

Level	XP to reach next level	Δ XP
31	14150	+ 150
32	14300	+ 150
33	14450	+ 150
34	14600	+ 150
35	14750	+ 150
36	14900	+ 150
37	15050	+ 150
38	15200	+ 150
39	15350	+ 150
40	15500	+ 150
41	15650	+ 150
42	15800	+ 150
43	15950	+ 150
44	16100	+ 150
45	16250	+ 150

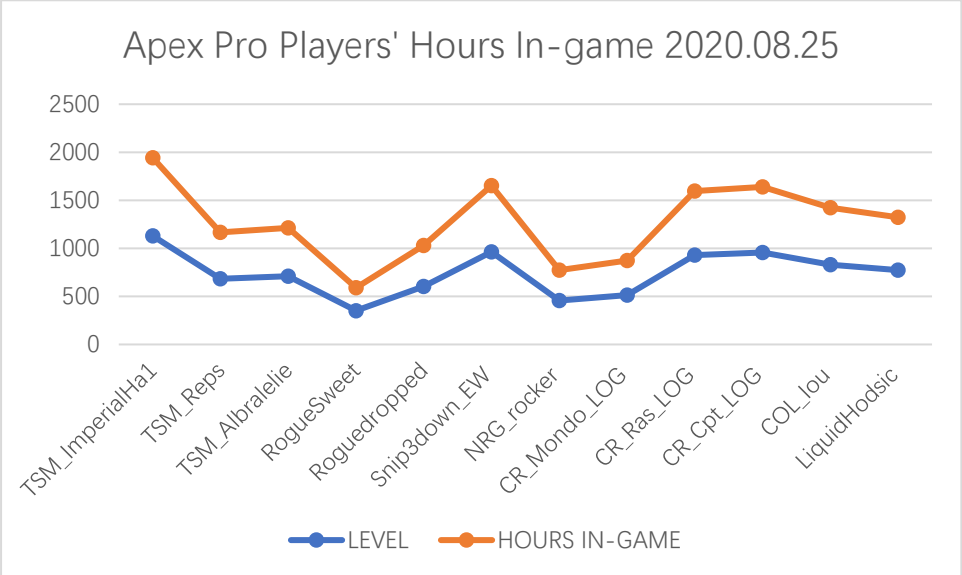
Level	XP to reach next level	Δ XP
46	16400	+ 150
47	16550	+ 150
48	16700	+ 150
49	16850	+ 150
50	17000	+ 150
51	17150	+ 150
52	17300	+ 150
53	17450	+ 150
54	17600	+ 150
55	17750	+ 150
56	17900	+ 150
57	18000	+ 100
58+	18000	+ 0

Source: Gamepedia

I found 8 times ‘level up’ in FunFps game videos, he is already 500 level, so each of them worth 18000 experience points. I calculated the average time he got 18000xp and use it to estimate these pro players’ game time.

I will show specific statistics in other part of the article, and here I will only mention the conclusion.

The following is my estimate of the game time of some professional players (the level is accurate, the game time is estimated, and all numbers remain integer):



Result

It can be seen from the figure that RogueSweet entered the professional field after less than 600 hours of gaming experience. Rocker and Mondo also joined the professional arena after less than 1,000 hours of gaming experience. The remaining players' game market did not even more than 2000 hours. Of course, Apex is a relatively new game. It was released in February 2019. Players only have one and a half years to play this game at most, so the average game time are smaller than other games. In this case, player like Sweet and Rocker's hours in-game are too short to be a pro player, which may be persuasive. In summary, Apex will get a lower evaluation than CSGO.

Tom Clancy's Rainbow Six: Siege

R6 is known to be difficult to get started. A large number of players said that they did not get started until after 1,000 hours of gaming. R6 uses the CS: GO game mode, rich game learning content constructed by different operators, and the most important game mechanism, the detachable wooden wall. These characteristics make R6 difficult to fully understand. The detachable wooden wall made vertical play a reality, it turned the former flat CQB (Close Quarter Battle) into a real three-dimensional in strategy perspective, created a new dimension for FPS game. Some game content of CS: GO, including movement skills, tactics, aiming skills, etc., are inherited by R6, but the only completely different is the throwing objects. The throwing system of R6

is completely different, but it is still very creative. Players can throw out various results through a simple throwing system.

Method

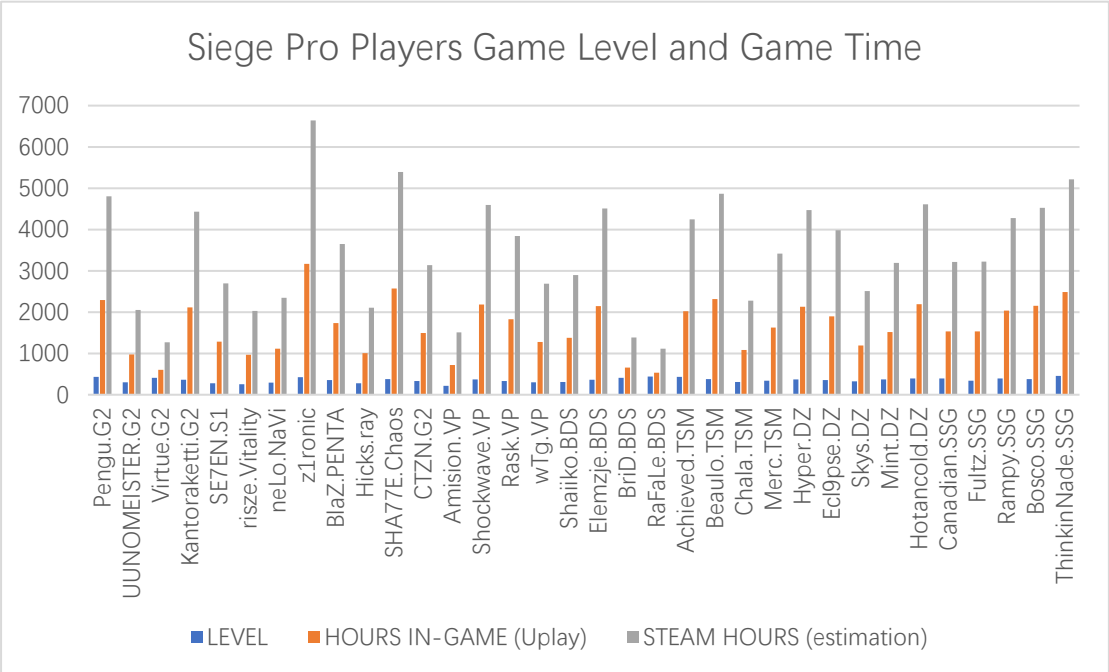
the game time of R6 is the net game time, while the game time of CS: GO is calculated by Steam. As long as the game is opened, it will be calculated. This will cause the waiting time to be recorded. Generally speaking, the net game time at least twice the Steam game time. In this case, this report found some accounts with known game time both in Uplay (net game time) and Steam.

ID	Uplay time	Steam time	Ratio
Mike7777777_	356	730	2.050561798
Mike_DCI	237	570	2.405063291
Mike.GKD	93	239	2.569892473
RZH_DCI	1140	2730	2.394736842
SS_Florence	472	884	1.872881356
Barry_DCI	560	1143	2.041071429
kaga.OFN	640	1219	1.9046875
Pinpineapplepen	343	677	1.973760933
REVO_ono	549	1106	2.014571949
BleuFonce	1759	3422	1.945423536
Klein_DCI	611	1172	1.918166939
Jabin.Obect	330	1192	3.612121212

Finally, we found that the ratio is about 2.22. After discovering this ratio, this report searched some R6 pro players' profile, and estimated their play time.

Result

Sort the data as follows:



The ones with low game time and level are UUNOMEISTER.G2 (304,977) risze. Vitality (252,968) Amision.VP (215,720).

It is worth mentioning that Rainbow Six is a special game. Individual players do not need to have a deep understanding of the game. As long as they listen to the coach's arrangements and can complete the designated tasks, they can have a place in the professional arena. Coincidentally, UUNO and Amision are often the first/second breakthrough players in the team (SIEGEGG, 2020).

When we look at the Steam time, it is true that a small number of players can enter the professional arena in about 1,000 hours with the original FPS game foundation and excellent game talent, but when we see the average is still relatively high 3444 hours. Rainbow Six was officially released in 2015, and five years have passed by 2020, but the popularity of Rainbow Six can never be compared to CS: GO. At the same time, Rainbow Six’s knowledge required for classic fps has more tactics than CSGO. In addition to dynamic feedback, there are a lot of static content that needs to be recited, a lot of spawn peek spots or rat spots that need to be practiced. Therefore, this article believes that Rainbow Six, as an online game that embeds successful tactical competition in fps, has higher complexity and learnable content than CSGO.

Others

Valorant

Valorant completely copied the game mode of CS: GO, and then added the character system in overwatch. From the perspective of game integration, Valorant's game complexity and the depth of learning content must be higher than that of CSGO.

Overwatch

OW (Overwatch) is a new thing for FPS. It has won numerous awards, including being named the best game of the year by D.I.C.E in the 2016 Game Awards (Makuch & Imms, 2017). It is always difficult to evaluate new things, especially when so many magazines, institutions, and forums select it as the best game of the year. OW is like a combination of MOBA and FPS. Each hero has different skills, making him very good at balancing players who are good at different content. Let's take a look at ordinary MOBA games, like Dota or LOL. In these games, players usually need to learn a lot of game knowledge. Some knowledge needs to be practiced. It takes time to master it, but more knowledge is static. On the contrary, the classic FPS game has only a few truths, the rest are practice, practice, practice, in the exercise to explore more knowledge, the book written into muscle memory, when encountering every different situation and accident when the reasonable use of their abilities. While OW and the classic MOBA game have very similar static learning content, and static learning content is easier to learn and less changeable, for this reason I think praise OW in any way is reasonable, but not necessarily in this perspective.

Call of Duty: War Zone & Battlefield V

Battlefield series of soldier-type systems, carrier systems, team systems evolved from traditional stand-alone FPS games, maintaining the authenticity and complexity of combat.

Call of Duty: War zone is a good escape game, experienced a very multi-generational inheritance and development, there are many unique game pictures, shooting feel, firearms data. But these systems do not make the game as difficult to learn as it should be.

Hyper Scape

Hyper Scape is only released in 2020, and it's hard to comment on the thickness of his game. In the simplest way, it's simpler than other games in terms of movement, gunfight, throwing, tactic, teamwork, and so on.

Escape from Tarkov

Escape from Tarkov is not an e-sports game, so there is not enough evidence to show its game complexity and depth of learning.

Summary

In this section, R6 is the best game, while Valeant is second, CS: GO is third, and the rest of the game is not doing very well in this regard. The depth of the game is one of the most important factors in whether a player can invest time in it. Now, let's look at it from a software developer's point of view.

Game engines should be very diverse, different engines have the ability to shape different styles and characteristics of the game. The merits of a game engine itself can partly influence the development team's exploration of game depth. This paper argues that, the company's game development department in the development of game content at the same time need to update the game engine, some game content needs to be modified game engine to achieve, such as smoke bomb style. Games developed based on the same game engine have shown a trend towards learning style and deep homogenization. While ensuring the quality of the game is stable, players need to be pleasantly surprised. Every FPS gaming field seems oversaturated, and each game has a similar game to compare, but the question is why Valorant can also be one of Twitch’s hottest games right now, with streamers and professional players turning to Valorant, including even some CSGO players. This article believes that excessive homogenization of the game and lack of root-roots innovation is one of the reasons why everyone is willing to try a new game.

On the other hand, attach importance to software engineering principles. Ensure that the project is carried out in a scientific way, do a good job plan, confirm project

requirements, and iteratively develop. This writing principle is not only applicable in the game testing stage, but also can ensure the ability of future game content to develop, create good conditions for the iteration of the game version, and is also a good way to increase the content of game learning. The chaotic version control of individual games is an important factor hindering the future development of the game. If the game itself has repeated BUGs after multiple versions, it proves that the version control of this game is very bad. As one of the most basic development capabilities, version control is not applied in every game. The most obvious example is R6. Although R6 has excellent game depth, like other fps games, his game depth was almost the same when it was just released, and it rarely changed in the next five years. If a game can bring completely different game components to players in stages, I think this is more exciting than launching an activity mode or map every season. Of course, another consideration is that if a game has already been popular with the public, it is a very good strategy not to make drastic changes. When game companies have a better idea, they are usually happy to implement the idea in a new game. This is understandable. If an update can really change the game, then controlling the intensity of the update or letting it appear in a way that does not change the previous game is a good solution.

One should not expect any game to be as complex as a centuries-old discipline in the real world, but any game requires a certain depth of learning to attract players to spend time playing it.

3.3.2 Time cost-effectiveness of game learning

Whether a game can get players into the situation quickly determines the player retention rate to a large extent. When players have put in a lot of hard work but the progress in exchange for it is negligible, few people can stick to it. There are mainly the following ways to improve the cost-effectiveness of learning:

First of all, the game needs to have a simple game mechanics. There cannot be too much content to practice. Developers need to simplify the core skills and concentrate the player's energy on a small part of the game. This can lower the game threshold for novices and encourage players to continue learning. Most traditional shooting games do a good job in this regard, but OW and R6 introduce some MOBA elements to make the core of the game more complicated.

Secondly, it is necessary for players to train effectively. A good practice mode allows players to fully experience the scenes that need to be faced in the game and fully practice the skills that need to be used in the game. This requires training mode not only to have a static training field, but also to become a separate game mode.

Finally, the game content needs to be repetitive. You can encounter similar situations many times in the game, you can practice repeatedly, and reflect what you have learned. This virtuous circle stimulates players to spend more time to master the game.

The mechanics of CSGO and most traditional FPS games are quite simple. There are many practice maps in the CSGO creative workshop. These maps provide players with a variety of practice options, covering almost all parts of the game.

Apex Legends is also a game with simple game mechanics. You can encounter a lot of similar situations in the game, which greatly increases the effective learning time. In battle royal games, it is hard to find repeat experience frequently, but Apex Legends did it well.

The mechanism simplification of Hyper Scape is the most thorough. The game has almost no learning cost. The game mechanism is simple. There is no backpack. Only guns and skills can be obtained on the map, and the bullets will be automatically

obtained.

Although Valorant's practice mode is closed source, it is still very good, including field scene simulation, close-range and long-range shooting practice, sensitivity adjustment and so on.

This article believes that Apex, Valorant and Hyper Scape all have a good learning cost performance. This article believes that FPS games should simplify the core game mechanism, make well-made training modes or open source training maps, and have high game repeatability.

3.3.3 Game experience with excessive skill differences

In a confrontational game, encountering opponents with too large a difference in strength is likely to make the game boring. There are many solutions to such problems, which can be roughly divided into two categories.

One is to solve the imbalance of the game itself, and the other is to find a way to bring the game level of masters and novices closer.

This article believes that it is necessary to ensure the maximum gap between the players in one match. This way of narrowing the game performance of players of different levels is completely contrary to the goal of reducing surprises. If the player's balance skills are too obvious, then the strong and weak players will feel that the game is unfair (Rodrigo, Regan& Carl, 2015). This paper refers to this type of solution as a passive solution.

On this basis, all games should pay attention to the quality of matchmaking. Because players of different levels are put together to play, they will not experience a good game experience, then this game will become extremely difficult. Research shows that the balance of player levels is valuable, because the fun increases when the players play more evenly (Bateman et all., 2011). Multiple studies have proven this result-for example, in a study of siblings, if younger children never perform as well as older siblings, then they will become depressed or lose their ability to continue playing (Go, Ballagas & Spasojevic, 2012). A counter-intuitive research result is that an excellent player level balance system will greatly improve the game experience of players with poor levels, and at the same time, the game experience of players with better levels will not be lost, but will also get a small increase(Rodrigo et all., 2015). This article refers to this type of solution as actively solving the problem of player level differences.

The imbalance of the matchmaking needs to be controlled, and the more important aspect is to narrow the gap between the player and the player's previous level by modifying the game mechanism and other aspects.

Next, I will state some of the balancing methods and effects in the game. In the end, I

will try to demonstrate that developers need to explore more ways to balance players. A common balancing method is to add more optional roles, refine the player's position in the game, and allow players with different advantages to contribute to the team in a position where they are good at. Another method is assisted aiming, usually through Sticky Targets (to reduce the sensitivity of the mouse when aiming at the target) and Target Gravity (to automatically pull the mouse to the target) (Rodrigo et all., 2015).

CS: GO

CS: GO’s matchmaking system is mainly divided into official matching and third-party platform matching methods. Valve has never officially announced the CSGO matching mechanism, but the community widely believes that they use the glicko2 algorithm to calculate the player's level to obtain better matchmaking. CS: GO's statistical system is relatively complete, and there are a lot of data that can be used to analyse the level of players, which is why CS: GO has done a lot of work in finding reasonable games. Glicko2 adds a level deviation RD variable after the player's level, that is, MMR, so that the player's level will fluctuate in a certain range instead of a fixed number. As you play more games, this RD will become smaller. In addition, this system also introduces volatility variable, when the player shows unstable performance, the value will increase, and vice versa, this value will also affect the rate of change of RD (Glickman, 2013; Weng & Lin, 2011).

Another mainstream algorithm is the ELO algorithm, that is, all players have specific scores, points are added when they win, and points are reduced when they fail. When a low-scoring player meets a high-scoring player in a game, too many points will not be deducted even if the game loses. Both systems focus on prediction. When a player exceeds the system's prediction, his scores will increase, and vice versa.

In addition, CSGO also introduces "credit", which will affect player matching. Players with low credit will usually only be matched to players with the same poor credit value.

Unfortunately, although CSGO has done a lot of work in passive aspects such as

matchmaking and player level definition, it has hardly any attempts to make the game experience better for players of different levels.

Valorant

Similar to CSGO, the only difference is the addition of a role system, which allows players who are good at other areas to perform better and contribute to the victory of the team. But it is still a csgo-like game, and the role is not based on skills, and marksmanship is a supplement.

Overwatch

OW is a revolutionary game that makes efforts in both active and passive ways.
OW's ranking mode is very unique. Players can choose to play in a 2-2-2 rank game mode, which contains two supporters, two DPSs (players cause most damage), and two Ts (players block most damage). Players can determine their own game type before ranking, and each player has a different ranking band for each type. This is an innovation based on Elo and completely different from CS: GO. This is an innovation derived from the game characteristics of OW itself. CS: GO has no role system, everyone is the same when spawn, while OW is different, each role is fixed by it. This is why it was able to create this very novel ranking system. From the perspective of this article, this is also a good attempt.
OW's matching mechanism may not be as successful as imagined, but it is still creative. At the same time, it demonstrates how a fps game can allow players from other fields to join in and enjoy it. It just allows players with different advantages to do contribution for the team. There are so many supporting roles. Let me try to list some typical roles classes.

- Entry-Fragger (DOOMFIST, GENJI, REAPER, TRACER): Move faster, usually weak in terms of health/armour, usually suitable for their weapons are submachine guns or shotguns, and they are good at close combat.
- Moderate role (Solider 76): A balanced role in all aspects, usually suitable for

single row or novice players.

- Heavy, Tank Class：On the opposite end of the spectrum from the last class. Runs very slow but has a lot of health, and a generally high-firepower gun. Difficult to take out head-on.
- Snipers (Ashe, Widowmaker, Hanzo): They use sniper rifles and have extremely high output, but they do not have a lot of health, and their close-range capabilities are poor.
- Support: The first thing I have to mention is Healer (ANA, Mercy, Moira), which is a doctor. Their main task is to help their teammates survive and improve their blood volume, but their survival ability is not strong. Volunteers are a broader definition. They can be tactical volunteers. In general, they can help teammates in all aspects to a large extent.
- Flanker (Genji, Reaper): They usually have some skills that can make their whereabouts difficult to capture, so that they can disappear from the enemy's field of vision. This type of player needs to be sensitive to the situation of the game, and also needs the ability to avoid the enemy's vision.

The diverse role system allows players with different expectations of the game to find the content they need to play, so that people with their own strengths can find a sense of accomplishment in the game. In addition, contents such as assisted aiming and assisted perspective also appeared in the game. For example,

- Soldier 76's ultimate, tactical visor. The precise aiming goggles on Soldier 76's face can "lock" the target of the attack on the enemy closest to the sight. If the enemy leaves the sight of soldier 76, the target will quickly switch to the next enemy.
- Widowmaker’s ultimate, infra-sight. Widowmaker’s recon visor allows her to see the heat signatures of her targets through walls and objects for a moderate amount of time. This enhanced vision is shared with her allies.
- Sombra’s passive skill, opportunist. Sombra can detect severely injured (less than 50% health) enemies through the wall.

- Symmetra has a sentry turret. Symmetra can launche a small turret that automatically fires speed-reducing blasts at the nearest enemy within range. Up to three turrets can be built on the battlefield at once.
- Torbjörn’s deploy turret which automatically tracks and attacks enemies.

These features have greatly improved the gaming experience of many players who are not good at traditional fps games.

FPS games have received a lot of criticism due to a very small number of female players (Yee, 2017), and OW is the game with the most female players in the industry (McKeand, 2017), which is impressive and very commendable. It is the mission of game designers and developers to allow more groups to join FPS games and balancing the game experience of different levels and types of players has made a great contribution.

Apex Legends

The matching mechanism is divided into solo queue and group queue. If the team is pre-grouped, all players will be matched according to the rank of the highest rank player in team. RP is a number that measures the level of players in the game. Players with more RP will rank higher. After reaching a certain number, their rank will be upgraded. Players will charge a certain amount of RP as the entrance fee for each qualifying match. As the rank increases, the entrance fee gets higher and higher, and positive behaviours in the game will reward RP, such as kills or assists, or Get the top ten, when your RP is higher than the entrance fee, you will get points. The advantage of such a system is transparency. Players can control their own scores without questioning their ranks. But for some auxiliary players, if their teammates are not strong enough, it will be difficult for them to improve their ranking scores.

Similar to OW, Apex also has many heroes. The difference is that Apex’s team only has three heroes, while OW requires 6 players. Similar to OW, AL also has a very high TTK. This kind of TTK makes it almost impossible to make surprises between players with too large a gap. However, in the sixth season of 2020, Rebirth Studio

made some changes. I did some survey statistics on this change and found that Apex has enhanced the game experience of players within a certain level and increased the acceptable surprises of the game by reducing TTK and changing certain game content. I will talk about the unexpected part in other parts, and then I will make some explanation and analysis of what happened in the sixth season.

Respawn Entertainment is making comprehensive changes to Apex Legends. The most critical change is to weaken the armour (i.e., electronically charged body armour) in the game. The amount of attack that all armour can resist is reduced by 25 points. The original three-level armour Armor can resist up to 100 points of damage, and now the third-level armour can only resist 75 points of damage. At the same time, all armours become EVO armours (that is, the armours are automatically evolved, the player causes a certain amount of damage, and the armour level is automatically upgraded). This small change has been criticized by some players because, as mentioned in the patch documentation, they are committed to shortening the TTK (Time-to-Kill) in the game. The reduction of TTK usually leads to the phenomenon that elite players are defeated by poor players. Especially when Apex is a game where it is difficult to have this situation due to the extremely high TTK before the 6th season, it is not difficult for players to question this aspect.

When such a change occurs in the game, our instinctive reaction is that the stability of the game will decrease, the game performance of the strong and the weak will be closer, cheaters will be more rampant, the team completeness in the late game may be reduced, and the players will be more frequent In danger, and harder to break free.

Method

This article takes FunFps, the anchor who has ranked first in Apex European servers many times, as an example, made a statistics, randomly selected the player’s live video of the fifth and sixth seasons, each for about 10 hours, and recorded each in detail. Item data to reflect the impact of the season update on high-level players. In order to ensure the uniform quality of the game, we have selected the game after the player enters the top 500, so that the level of opponents in each game in the two

seasons of video is close. What needs to be shown is that due to statistical limitations, the statistics can only one-sidedly reflect the game experience of the predators and nearby players in the qualifying stage.

Result

Statistics for the Season 5 of Apex Legends based on Twitch Streamer

Legend choiced	Ranking	Kills	Damage	Got into trouble	Injured	Finished	Available Team/Players After 3rd Ring	XP	Survival time(minutes	Level up time
S5 01 GIBRALTAR #120	9	3	1410	2	1	1	\	3035	12.4	
S5 02 CAUSTIC #120	10	1	834	4	1	1	\	2366	8.63	
S5 03 CAUSTIC #120	14	0	139	1	1	1	\	663	3.18	
S5 04 BLOODHOUND #120	2	6	2199	4	2	1	7/18	6323	20.43	
S5 05 BLOODHOUND #120	1	1	1720	5	1	1	3/7	8242	18.05	3:12:00
S5 06 BLOODHOUND #120	1	6	3894	3	1	1	9/23	7387	21.63	
S5 07 BLOODHOUND #120	11	0	392	1	1	1	\	1048	4.3	
S5 08 BLOODHOUND #57	4	3	1439	1	1	1	7/16	6438	20.45	
S5 09 BLOODHOUND #57	5	1	831	1	1	1	5/13	4660	15.3	
S5 10 BLOODHOUND #57	8	1	588	1	1	1	8/21	2949	13.9	
S5 11 GIBRALTAR #57	12	1	440	1	1	1	\	937	3.8	
S5 12 GIBRALTAR #57	1	5	1869	3	1	0	4/10	8803	19.97	
S5 13 GIBRALTAR #57	15	2	417	1	1	1	\	1544	4.12	
S5 14 GIBRALTAR #57	16	1	383	1	1	1	\	937	4	
S5 14 CRYPTO #57	10	0	582	1	1	1	\	1180	5.75	
S5 15 REVENANT #57	1	6	2223	1	1	0	3/7	9870	17.05	3:50:00
S5 16 REVENANT #57	8	4	823	2	1	1	7/15	4642	13.7	
S5 17 REVENANT #57	17	0	752	3	1	1	\	886	3.53	
S5 18 REVENANT #57	1	3	1951	1	0	0	7/18	8829	20.47	4:40:50
S5 19 REVENANT #57	10	3	989	3	2	1	\	2214	9.18	
S5 20 REVENANT #57	4	4	1093	5	5	3	6/15	5696	19.42	
S5 21 REVENANT #57	13	1	316	1	1	1	\	1071	4.77	
S5 22 REVENANT #57	7	3	1974	2	1	1	6/12	3473	14.3	
S5 23 REVENANT #57	18	0	90	2	2	1	\	634	3.1	5:48:01
S5 23 REVENANT #57	2	6	1855	1	1	1	5/13	6465	21.45	
S5 24 REVENANT #57	18	0	437	1	1	1	\	640	2.68	

Statistics for the Season 6 of Apex Legends based on Twitch Streamer

Legend choiced	Ranking	Kills	Damage	Got into trouble	Injured	Finished	Available Team/Players After 3rd Ring	XP	Survival time(minutes)	Level up time
S6 01 BLOODHOUND #4	11	2	450	2	1	1		1877	8.25	
S6 02 BLOODHOUND #4	4	0	1337	2	1	1	6/16 3/9	4317	17.16	
S6 03 BLOODHOUND #4	2	1	938	3	1	1	5/13 4/10	5377	22.51	
S6 04 BLOODHOUND #4	6	3	668	2	2	1	5/10 4/?	4000	14.01	
S6 05 BLOODHOUND #4	6	2	1292	7	5	2	6/13 5/10	4162	16.14	
S6 06 BLOODHOUND #4	1	5	1209	0	0	0	5/8 3/?	6046	18.52	
S6 07 BLOODHOUND #4	11	1	730	1	1	1		3435	13.32	2:43:11
S6 08 BLOODHOUND #4	11	0	0	1	1	1		376	1.54	
S6 09 BANGALORE #4	1	3	1622	5	2	0	9/25 4/12	6377	22.08	
S6 10 RAMPART #4	8	0	221	2	2	2	7/17	2678	13.15	
S6 11 RAMPART #4	4	5	1979	3	1	1	5/12 4/10	5278	17.42	
S6 12 RAMPART #4	7	2	1119	5	2	1	5/10	2371	11.04	5:30:10
S6 13 RAMPART #4	20	0	0	1	1	1		609	3.05	
S6 14 BLOODHOUND #4	18	0	247	1	1	1		842	3.57	
S6 15 BLOODHOUND #4	2	1	1016	3	2	1	6/16 5/11	4799	20.17	
S6 16 BLOODHOUND #4	2	6	1028	2	1	1	7/14 4/10	4990	19.43	
S6 17 BLOODHOUND #4	2	6	1028	1	1	1	6/13	4990	19.43	
S6 18 BLOODHOUND #4	15	2	371	1	1	1		1865	8.27	
S6 19 BLOODHOUND #4	17	0	85	1	1	1		472	2.17	
S6 20 BLOODHOUND #4	2	5	1251	1	1	1	5/14	5248	14.06	7:54:18
S6 21 RAMPART #4	12	0	187	1	1	1		1687	9.07	
S6 22 RAMPART #4	4	0	452	3	1	1	9/23 7/13	4797	19.34	
S6 23 RAMPART #4	1	2	846	1	0	0	6/13	5566	21.35	
S6 24 RAMPART #4	6	1	262	1	1	1		2443	11.46	
S6 25 RAMPART #4	3	1	884	3	2	1	5/14 4/10	5424	19.25	10:11:55
S6 26 RAMPART #1	13	2	317	1	1	1		1250	5.25	
S6 27 RAMPART #4	1	1	1270	3	1	1	5/13 4/11	5359	21.14	
S6 28 RAMPART #4	2	0	1200	1	1	1	5/13	5137	17.49	
S6 29 GIBRALTAR #4	10	2	239	2	1	1		1890	8.45	

Statistics have also confirmed that some of the guesses are correct. The incomplete value of the finals team increased by 7% compared with the original, the percentage of knockouts ended slightly increased (3%), and the survival time increased by about 18%. The average ranking increased by about 18%, the average KD decreased by about 22%, and the average injury decreased by about 33%.

From the above data, we can guess that the changes in this season make it easier for players to fall into danger and get injured, but the mortality rate after injured is lower than that of last season. This season the teams have more injured during battle, and there are fewer chances to finish for the fallen enemy safely, and more 2-man teams or

solo teams can be found in the late matches. Although the game allows good players to still win more games, the damage caused by the player and K/D all indicate that the gap between his fighting level and others is narrowing this season.

Apex's sixth season used a counter-logic approach to shorten the gap between TTK and similar players in qualifying through a bold update to change the game mechanics.

The changes in Apex Season 6 are difficult to evaluate, because there is no stable data indicating that this update does accurately control the game performance of a certain level of players. After such a large modification, players need a certain amount of time to adapt, although I choose the clips are all played by players who are very good at the game, but we can still assume that this update reduces the game performance of all players in a short period of time, instead of the developer perfectly controlling the balance of stability and excitement . But we should at least give EA some appreciation for the diverse game roles and skill modes.

Tom Clancy's Rainbow 6: Siege

In terms of matching mechanism, Rainbow Six is relatively moderate, and the matching system is not bad, but some players criticize the game for often matching themselves to matches that do not meet their own level. Rainbow Six uses an Elo-based evaluation system and a matching mechanism. We usually think that the MMR of leisure and ranked modes are not in the same system. This article will mainly describe the ranked matching mechanism.

In the ranking, Rainbow Six uses the TrueSkill algorithm (Ubisoft, 2016), which is similar to but slightly different from the Glicko-2 used by CSGO. This algorithm was first applied to Xbox Live. TrueSkill takes into account the uncertainty of the player's level. As the player plays more and more games, his MMR change will be relatively smaller at the end of the game, and his score will become more and more difficult to change (Herbrich, Minka & Graepel, 2007). This system allows the player’s MMR to match their real level as much as possible, but the R6’s 10-round grading match and

the lack of effective ways to avoid deranking, smurfing and other behaviours have made the matching experience not reach the average level.

In terms of game content, R6 has made efforts to produce more types of characters and provide different game mechanisms.

R6 also has many different roles. In addition to the Healer, Sniper, Defender, Flanker, Front-Line and simple Supporter just mentioned, there are Roamer, Entry Fragger, Anti-Roamer, Hard Beacher, Soft Beacher, etc. Kinds of role types. R6 is classified by rich and solid characters. At the same time, R6 has a lot of knowledge that needs to be memorized or innovated. A large amount of knowledge distinguishes two different types of players, one with strong mechanical ability and one with a better understanding of this. The game also knows more tactics and skills. The latter is not very dependent on gunfights more often but rely on their own experience and consciousness to win the game. Sometimes you do not need to shoot to win a game, but it’s still hard to conceal its true nature of FPS games. It is qualitatively different from OW. OW can easily balance the roles, R6 is even more difficult. This has a lot to do with the extremely short TTK of R6.

Using highly differentiated roles to allow more players to have their favourite operators to use is an effective way to balance the level of players (Rodrigo et all., 2015). There are three shielded operators in R6, Blitz from Germany, Montagne from France, and Clash from the UK. Their appearance has greatly changed the gameplay. When you use these three operators, especially Montagne, you do not even need to click the left mouse button (the left button is usually the shooting button in FPS games) to win the game in extreme situations. This type of player only needs ping, movement skill and some small skills and command teammates through voice, which can greatly affect the result of the game. A good shield operator will make the opponent very desperate. Many players even hope that Rainbow Six will delete the shield operator, but at the same time, many players play the shield operator, which is also a point of Ubisoft's success.

Hyper Scape

Hyper Scape is a game developed by Ubisoft in the post-Battle Royale period. It has been in public beta in July 2020. Although it is still an early game version, you can still see its efforts to balance the game.

First of all, although each role is the same, you can choose your favourite skill, namely Hacks. This allows players to customize their own game characters, play to their strengths to a certain extent, and of course choose their favourite weapons. There are no restrictions on the weapons here for all players. You can use them as long as you pick them up. Second, Ubisoft designed a D-Tap automatic aiming pistol, which allows players with poor aiming to use this gun to help them. This kind of change that does not disrupt the balance of the game is admirable. This article believes that the attempt being made by Hyper Scape is very meaningful.

Summary

In summary, it seems that solving the matchmaking problem is a better and more direct solution. However, this article believes that the exploration of active balancing schemes is more meaningful for solving problems.

The first solution is what every game is doing. Every game hope that its matching system can help players improve the game experience, rather than destroy them. Game developers have always tried to control the game skills of players in the same game on the same level, which does not always work.

The current matching mechanisms of popular games are almost all based on the analysis of player data such as game level and win rate. However, this kind of limited prediction of players often has problems because no matchmaking systems are perfect. A large number of games are using algorithms developed by Elo, but because each game is very different, various algorithms with no essential differences are not very helpful to a particular game, except for mathematical research. The rest can only be simple attempts to the game evaluation mechanism, such as OW and Valorant.

However, the exploration of the second method is insufficient. The current games on the market do not fully consider the impact of the second method on the game. OW

has done a very good job as a classic game, and HyperScape is currently doing some good New try.

3.3.4 Accident control

An accident is like a joke, it's funny when everyone finds it funny. The so-called accidents are things that happened unexpectedly, including "overestimating the opponent's game level and leading to mistakes", "wrong game operations are rewarded", "counter-intuitive game mechanisms lead to accidents in players", and "caused by lack of normal game knowledge." Accident" and so on.

Unexpectedness is the opposite of the previous theme "actively bring players closer to the game". It is dedicated to making better players steadily gain more victories and a higher winning percentage. If you only consider stability and reduce unexpectedness, the game will become boring. Players who have a little difference in the level of the game will be enlarged, making the wonderful game a boring game without suspense; If you only consider the excitement of the game, and the game performance of players of different levels is narrowed, not only will it make the strong feel unfair and boring, it will also weaken the player’s motivation to practice advanced skills.

Some games are proud of accidents. In order to imitate the real situation of human beings shot, they have extremely low TTK, and even headshots can be directly killed. Regardless of the distance and firearms, this type of game is usually not suitable for e-sports, because e-sports No need for nonsensical surprises.

If you want to improve the stability of the game, the easiest way is to increase the TTK, make each player's health bar thicker, reduce the number of explosive weapons, reduce the possibility of a fatal blow, and provide a resurrection mechanism. In fact, this is what the games do well in accident control are doing, such as Apex Legends and Hyper Scape.

3.3.5 Effective participation time

Let players participate as much as possible in a game, which will improve the player's gaming experience. Especially when the player dies, the article divides the game into battle royal and other types.

For the battle royal game, there are currently three main ways to deal with it on the market, namely the traditional method and two different resurrection mechanisms.

Traditional Method: PUBG and other games hardly provide a death perspective, that is, you can only choose to watch your teammates' perspective, and use voice to help teammates synchronize information.

Resurrection type: Apex Legends, COD: War Zone can be resurrected, Apex Legend picks up the banner, and War Zone is a little more complicated. For the first time, the dead player has the opportunity to enter an arena to fight with dead players like themselves. The winner can be resurrected directly, while the losing player can only request the surviving teammates to spend money to resurrect themselves with currency.

New resurrection type: Hyper Scape provides a brand-new mode, which will become Echo after the player dies. The world where Echo is located can see the surviving players on the map and inform teammates, but they do not have guns or skills. Can only move around. When you find a respawn spot caused by the death of an enemy, you can ask your teammates to resurrect.

For non-Battle Royale games, OW and other games will allow players to experience a period of cooling. During this period, players can only watch other players' games. Players can respawn after cold down. This is also a special resurrection mechanism.

In CSGO and most non-Battle Royale FPS games, the game only allows the player to watch the teammate’s perspective or a certain supporting perspective. For example, the Rainbow Six player can watch the teammate’s camera feedback to the teammate after death.

This article believes that for the battle royal game, the resurrection mechanism is a very critical part, which directly affects the length of time the player actually

participates in the game. The resurrection mechanisms of COD and Apex are similar, and Hyper Scape's attempts have not made a difference with their resurrection methods. For other types of FPS, the resurrection becomes strange. OW will automatically resurrect after death. CS: GO and R6 have a short time per game. It is more difficult for players to get bored because of death. This makes players actually have a strong participation regardless of death or not.

3.3.6 Performance optimization

Although hardware advancements are huge, game optimization is still very important. Steam is one of the world's largest gaming platforms. In their monthly survey, Nvidia's GTX1060 graphics card has long been ranked first by an overwhelming advantage (nearly doubled the second place), the resolution most commonly used by players It is still 1920×1080 (Steam, 2020).

For FPS games, the number of frames is life. Claypool pointed out in 2007 that trading a lower resolution for a higher refresh rate is a cost-effective business. The shooting performance of 60fps players is 7 times higher than that of 3fps players. The drop-in frame rate first affects shooting performance and then mobility. Whether an FPS game can run to an average refresh rate of 60Hz on a low-end graphics card with low special effects has also become an indicator for judging a game optimization. More professional e-sports players and live broadcasters have higher standards. If your game can only use 30 frames on the 1060 graphics card, then you will lose a large number of potential game users.

What needs to be clear is that game optimization is not just about improving the refresh rate of the game, but in many aspects. In addition to the refresh rate, the smoothness of the game, interactive delay control, loading time control, memory usage and game volume are all considered to be one of the optimizations.

People usually divide optimization into three parts. First, the root optimization of the engine, then the optimization of the game maker, and finally the optimization of the characteristic game by the graphics card manufacturer. The most important and the most amended is the optimization of the engine, but the current game industry is doing more optimization of game developers and optimization of graphics card manufacturers.

In actual development, game developers can use a variety of algorithms and techniques to improve the performance of the game and use some strategies to reduce the required configuration of the game without greatly affecting the quality of the

game. This big area is a problem that computer professionals need to solve, and developers usually only need to use engines and optimize components.

In fact, the game industry is only one of the industries that need to use computer technology. Like other industries, it needs algorithm engineers and different types of developers.

We can see from a study of the Quake III Arena source code (Lomont, 2003) that in the early game engines, there were many outstanding genius ideas and exploration spirits.

The author of the article studied a piece of code used to calculate the reciprocal square root in the game. The code uses Newton's method and a clever number, which makes the method four times faster than the original method, and the maximum relative error of all floating-point numbers is 0.00175228. Since this method is often used in games, optimizing this method will greatly improve the performance of the game.

Additionally, this code was written by John Carmack, one of the founders of id software, a very legendary game programmer.

This article believes that the engine market is becoming more mature, and it is difficult to make major breakthroughs in game optimization. We can only look forward to the continuous improvement of hardware capabilities. But if there is a next-generation engine in the future, its underlying code must be very beautiful, smart and efficient.

4 Conclusion

This article hopes to sort out the development history of the FPS game industry, analyse the content and development of the game through reasonable evaluation criteria, and further predict the future development of the industry.

In terms of history, the game evolved from the original arcade machine to the home machine, and then appeared on the game console. The current latest games basically run on the PC. After years of development, FPS has matured, and the form of the game has changed from single player to multiplayer. After that, the article detailed the CS: GO e-sports road and the impact of live broadcast on the game. At the end, it specifically mentioned Hyper Scape's attempt to connect the audience and the game more closely.

In terms of development tools, the article introduces various FPS commonly used game engines in detail and points out that the article believes that most game companies still do not think it is a good thing to open the engine source code. The article predicts that game companies with better engines will gain an advantage in the future, as a software engineer, there will be more opportunities in the field of game development. After that, the article made predictions on the future development of different engines, and was optimistic about the future development of Frostbite, Unreal and AnvilNext series.

The article also analyses FPS game development from multiple angles. The following are the main conclusions of the article.

In terms of the depth of the game content, the article believes that updating the game engine will help the depth of the game; the iterative development of game functions can lead to more updates that change the depth of the game. R6, Valorant, CS: GO are better games in this regard.

In terms of the speed of game progress, the article’s suggestion is to simplify the core content of the game; allow players to train more easily; and have a high degree of repetition. HyperScape, Apex, and Valorant are good games in this regard.

In terms of player level balance, the article believes that proactively narrowing the game performance of players of different levels is beneficial to the gaming experience of both parties; in the future, developers should try to actively solve the problem of game imbalance instead of passively. Hyper Scape, OW is a better game in this regard.

In terms of accidental control, the article argues that although controlling accidental can ensure the player's stable performance, it will also lose some authenticity and fun; making it more difficult for players to be injured or making death less terrible is an effective accidental control method. Apex, Hyper Scape is a better game in this regard.

In terms of effective participation time, the resurrection mechanism is more important for battle royal games, and for CSGO or R6, the game needs to find other ways to let dead players get more game experience. CS: GO, R6, Hyper Scape, Apex Legends, and COD are better games in this regard.

In terms of game optimization, the article believes that it is difficult for game engines to make major breakthroughs in optimization. Algorithms and optimization will be very important in the development of the next generation of engines.

In short, after the rapid development in the early stage, the problem of homogeneity has begun to appear in game engines and game development. Live broadcast and e-sports are currently the most popular areas. The game industry has now entered a stable period of development, with head engines represented by Frostbite, Unreal, and AnvilNext. Game companies regard game engines as one of the most important assets. At present, game optimization is still a big problem, and the performance of the game engine optimizes the hardware. In the future, the optimization of game engines will depend on the application of underlying algorithms and technologies, rather than at the higher level.

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