A Brief History of Computer Games

Mark Overmars, January 30, 2012

To design the computer games of the future, you need to understand the games of the present. And the games of the present are rooted in the games of the past. To this end we will give a brief overview of the most important developments in computer games over the past fifty years. Of course we cannot be complete. There are a number of books that are completely devoted to the history of computer games and some websites if you want to learn more about them. See the section on Further Reading for details.

The changes over the past fifty years can globally be categorized in a number of different types, which all influenced each other:

- **Changes in the hardware for playing games.** These developments had a huge effect on what was possible in computer games and, hence, enabled the game designers to make different and more fascinating games. We went from devices with minimal computing power, memory, and graphics to the consoles of today with special 3D graphics cards, DVD disks to store game data, and Internet connectivity.

- **Changes in interaction devices.** Over the years the devices we use to control the games have also changed. Early game consoles had special rotating knobs or simple joysticks and a few buttons. Nowadays game controllers have multiple joysticks, and lots of buttons. And in recent years this has been extended with devices that measure movement, like the Wii controllers of Nintendo or the Kinect system of Microsoft. Obviously these had a strong impact on the game play.

- **Changes in the software tools available.** Initially game developers wrote every line of code themselves (often in assembly language) and drew every pixel of the artwork. Nowadays extensive game engines and other middleware packages are available allowing for much more sophisticated games. And artist, animators, and level designers use advanced tools that help them to create complicated artwork efficiently.

- **Changes in the game business.** Game companies have considerably changed over the past fifty years. While initially games were developed primarily by individuals, nowadays there are huge teams of specialists working on a single game. Development budgets have grown from a few thousand dollars to tens of millions of dollars per game. Also educational programs have appeared to train the professionals needed by the game industry.

- **Changed in the demographics of the players.** While initially games were primarily played by young males, this has considerably changed in recent years. The number of female players is

close to the number of male players, and the age of players ranges from 4 to 100. This has led to new genres of games.

- **Diversification.** Initially, computer games were primarily played on arcade machines. Over the years the variety of platforms increased considerably. Nowadays we play games on consoles, personal computers, handheld devices, telephones, TV set-top boxes, etc. Also the type of players has diversified, as has the ways people like to play (for example casual, online, or hardcore). All of these devices and ways of play come with their own business models and development budgets.

- **Changes in the design of games.** All these changes have in turn led to considerable changes in the design of games. Game designers used the new hardware and interaction devices to create new forms of immersive gameplay. They created games that attracted different demographics. And they started to better understand better what makes an interesting game.

The past of computer games changes every day so a document about it can never be up-to-date. So the past in this document runs until 2011.

Chronology

I will first describe some of the major milestones in the history of computer games that everybody should know.

1950 – 1959

The first computer game that was ever created was probably the game *OXO* by Alexander Douglas in 1952. It was a version of tic-tac-toe that he wrote for his thesis on human computer interaction. But most people consider the real first interactive computer game to be *Tennis for Two*, developed in 1958 by nuclear physicist William Higginbotham for visitors of the Brookhaven National Laboratory. His game was meant to instruct players about the effects of gravity. Of course these early developers never realized the potential of games, partly because of the huge amount of equipment that was required.
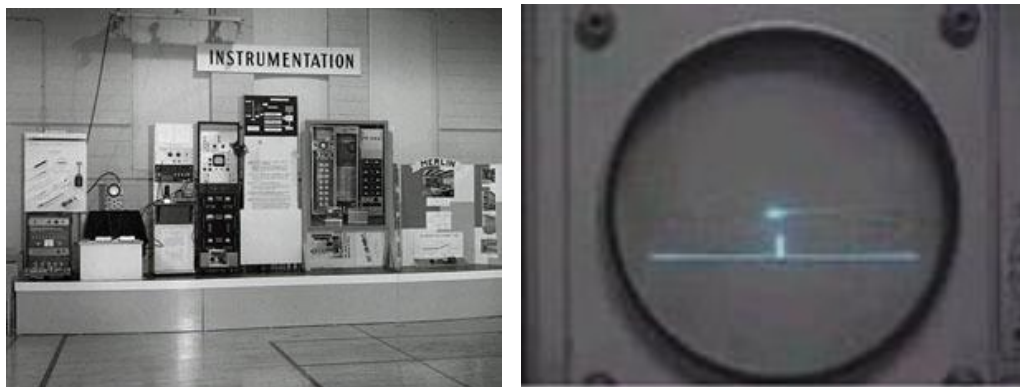

Figure 1 *Tennis for Two* **and the equipment required for it.**

1960 – 1969

Another early game was *Spacewar!* developed in 1961 by MIT student Steve Russell on a PDP1 computer[1]. A number of other games were created on this machine by students, including *Lunar Landing*.
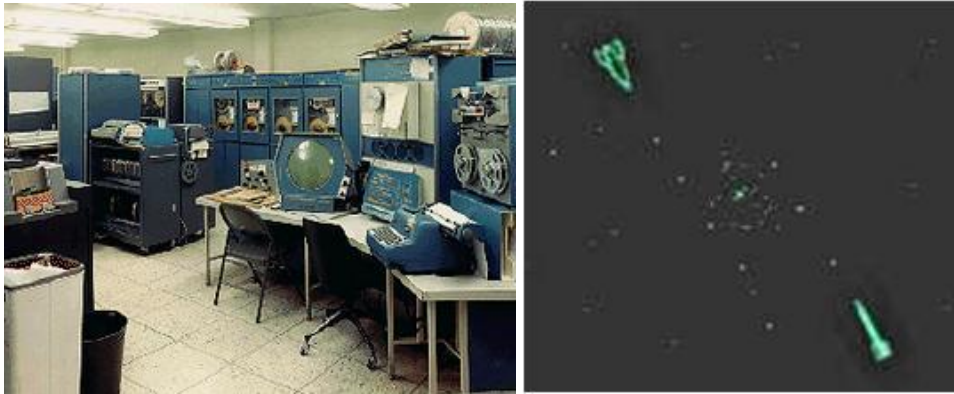

Figure 2 A PDP1 and the game *Spacewar!*

In the second half of the decade a number of people and companies started to seriously consider the commercial exploitation of computer games. In 1966 Sega releases the arcade game *Periscope* which, although not really a computer game, did show the possibilities of arcade game machines. And Ralph Baer started researching interactive television, which led to the Odyssey game console, released in 1972.

1970 – 1979

This is often referred to as the golden age for video arcade games. The first commercial exploitation of computer games came through the arcade machines. These machines were allowed to cost a considerable amount of money, making it commercially feasible to exploit computer games. The first arcade computer game *Computer Space* appeared in 1971 but was not a commercial success. The creators though did not give up, founded Atari, and in 1972 produced the *Pong* game which was a huge commercial success. (One of the interesting stories is that when they put their first machine in a bar, within two weeks it was reported to have broken down. But the actual problem was that due to the huge number of quarters that were thrown in, the pay-slot system had stopped working.)

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[1] See http://pdp-1.computerhistory.org/pdp-1/?f=theme&s=4&ss=3

Figure 3 The Pong arcade machine by Atari.

Soon Atari was followed by many other companies and new interesting games were created. *Breakout* appeared in 1976, and also *Space Wars* that for the first time used vector graphics. In 1978 color was introduced and *Space Invaders* was produced by Midway, in 1979 *Asteroids* appeared (with 50.000 machines sold worldwide the biggest success), and in 1980 the highly popular game *Pac-Man* was created. (It was originally named *Puck-Man* but the distributor was afraid people might scratch away part of the letter P. Another interesting story is that the game led to a coin shortage in Japan.) A noteworthy game was *Death Race* that appeared in 1976. In this game you had to control a car and your goal was to run down as many "gremlins" as you could. Even though the graphics was pixilated with the gremlins looking like stick men, the game caused a lot of controversy which led to its end[2].
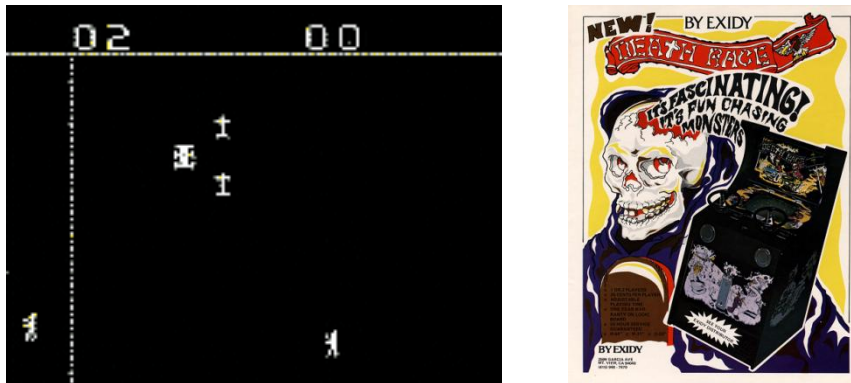

Figure 4 The game *Death Race*, causing controversy.

[2] For more information see e.g. http://en.wikipedia.org/wiki/Death_Race_(video_game)

Also home consoles were starting to appear that could be connected to the TV set. The first was the *Odyssey* in 1972 of which about 100.000 units were sold. It could only move some dots on the screen and used plastic overlays for the TV to add colored playfields[3].

Figure 5 The Odyssey that came with lots of extras, including plastic screen overlays.

In 1976 the Channel F system appeared that for the first time used cartridges for the games, making it possible to play different games on the same system, which was a very important innovation. The big step though came in 1977 when Atari introduced the VCS system (also named the Atari 2600). Initially it did not sell very well, because the device was expensive and the games were not very good, but the turning point came in 1980 when Atari started to bundle the game *Space Invaders* with the device. It shows that in the end it is not the hardware that counts but the games. In total over 1000 different game cartridges were produced for the VCS. Over 30 million devices were sold and hundreds of millions of games[4].

These early devices were extremely limited in their hardware. For example, the Atari VCS initially had only 1 Kilobyte of memory for both the program (written in Assembly language) and the data. Programming interesting game play on them was a very challenging task. The limits on memory for example meant that playing fields often were symmetric. This saved data to store it.

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[3] For more information see e.g. http://en.wikipedia.org/wiki/Magnavox_Odyssey

[4] For more information see e.g. http://en.wikipedia.org/wiki/Atari_2600. For reviews and images of many of the games produced for the Atari 2600, see the site http://www.videogamecritic.net/2600.htm.

Figure 6 The Atari 2600 (or VCS) game console and the *Space Invaders* game.

1980 – 1989

The number of games increased rapidly. Many famous games were produced in this decade, like *Zork* (1980), *Donkey Kong* (1981), *Pole Position* (1982), *Pitfall* (1982), *Mario Bros.* (1983), *Dragon's Lair* (1983), *King'Quest* (1984), *Elite* (1984), *The Legend of Zelda* (1986), *Metroid* (1986), *Mega Man* (1987), *Final Fantasy* (1987), *Metal Gear* (1987), *Popoulos* (1989) and *Prince of Persia* (1989).

Figure 7 *Pittfall*, *Metroid*, and *Mega Man*.

Because of the success of companies like Atari, others soon followed. For example, Mattel introduced the IntelliVision in 1980 and in 1982 the ColecoVision appeared. Many companies appeared creating games for the various consoles, often of poor quality. And Atari, who was the market leader at that point, made some huge mistakes with games like *E.T.* that cost them millions of dollars and lost them the trust of their customers. (Atari bought the rights for *E.T.* from Spielberg for a reputed twenty-odd million dollars. To have the game ready for Christmas they had only six weeks to produce it. They managed but produced a game that is often cited as the worst game of all time.) As a result, consumers became confused and disappointed and the game console marker crashed in 1984. Many companies in the U.S. went bankrupt or stepped out of the game business. As a result, the focal point of game production shifted to Japan.

Another reason for the crash was the introduction of new game computers. Cheap personal computers appeared that were particularly suited for games because of their memory, graphics and sound capabilities. Probably the most famous are Radio Shack's TRS-80, the VIC-20, the ZX80 and the

Commodore 64. Atari also entered this market, in particular with their very popular Atari ST that was introduced in 1985. Games for these computers were easier to copy, because of floppy disks or cassette tapes. This also made it possible to save game progress, which allowed for more complex games. Before, the player always had to start the game from the beginning. So the game had to be completed in a single play session. The computers made it possible to store the status of the game and, as a result, the player could stop and continue playing at a later stage, allowing for games that took many hours to finish.

The crash of the console market made it possible for other companies to enter this market. Nintendo introduced their Nintendo Entertainment System (NES) in 1985 and the Sega Master System followed a year later. The NES came bundled with *Super Mario Bros.* and was an immediate success. Even though the Sega Master System was technological much more advanced than the NES, the NES was the most popular because of the high quality and uniqueness of its games (enforced by Nintendo through very strict publishing deals). It again showed that it is the games that matter, not the hardware. These devices had new gamepads with the directional-pad (or D-pad) rather than joysticks or turning knobs, that changed the way in which games could be played.

Figure 8 The Nintendo Entertainment System and the bundled game *Super Mario Bros*.

At the end of this decade an important new development happened. Nintendo introduced the Game Boy in 1989 as the first handheld gaming system. It came bundled with the game *Tetris* that made it very popular. *Tetris* was designed by the Russian scientist Alexei Pajitnov and is considered the most addictive game ever. (Even though there is some clear design error in it; when the player has trouble playing the game *Tetris* becomes harder because the blocks pile up, while it would be more logical to help the player and make the game easier.) The Game Boy was soon followed by the Sega Game Gear and the Atari Lynx. The latter has a color display, but neither was very successful, partly because of the short battery life. For a long time Nintendo was the prime producer of handhelds.
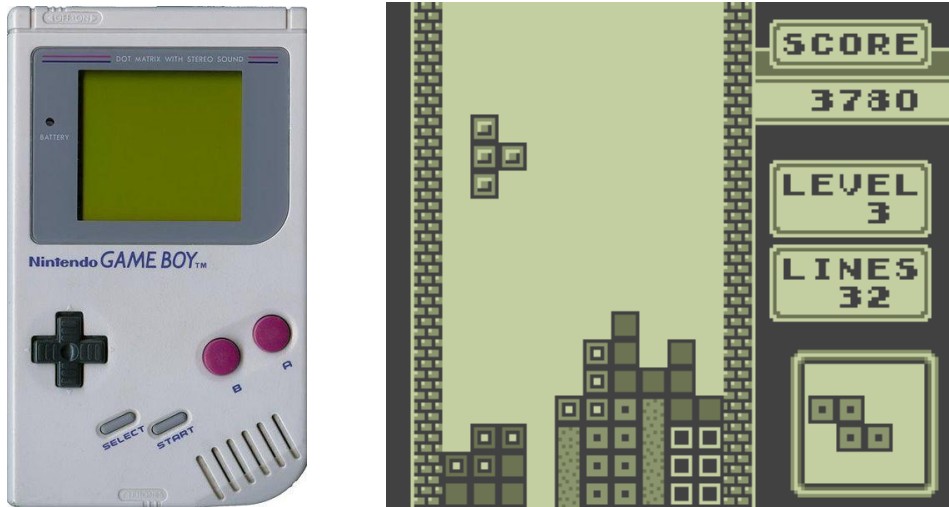
Figure 9 The Game Boy and the original game *Tetris.*

1990 – 1999

This decade saw a huge increase in the power of the game consoles, while at the same moment the popularity of the game arcade machines declined because they were no longer of superior quality. Sega introduced its Mega Drive, also called the Genesis, in 1989 soon followed by the Nintendo Super NES. Both were very successful. They were 16-bit systems with a much faster processor and more memory (64K for the Genesis and 128K for the Super NES). They had special hardware for drawing sprites and a higher screen resolution than previous consoles. While Nintendo had Mario as their main character, Sega introduced Sonic the Hedgedog. There were some other systems around but Sega and Nintendo had the majority of the market.

Figure 10 Sonic the Hedgehog by Sega.

Between 1994 and 1996 the next generation of game consoles appeared. Sega introduced the Saturn in 1994 and Nintendo the N64 in 1996. The newcomer was Sony who released the PlayStation in 1994. (There were some others but they had a small market share.) They used faster 32 or 64 bit processors and had much more memory (2-4 Mb). They also had special hardware for 3D graphics (although still

rather limited). The Saturn could draw 500.000 polygons per second, the PlayStation 360.000 and the N64 100.000 (or 500.000 with lower accuracy). They also had much improved sound systems, increasing the immergence in the games. The Saturn and PlayStation has a CD drive, giving games the possibility to have much more data. Nintendo continued to use the cartridge system because they claimed it would load faster. The N64 had the possibility to connect four controllers. Nintendo clearly started to focus on games that are played with the whole family. Something they have continued with great success since. The PlayStation was the easiest to program, which might be one of the factors that led to the huge number of titles that became available for it. Because of the 3D graphics and the increased expectations of the players the cost of producing games started to grow considerably. Game budgets of half a million dollars or more became common.

Figure 11 Some early games on the new consoles. From left to right: *Ridge Racer* **for the PlayStation,** *Virtua Fighter* **for the Saturn, and** *Super Mario 64* **for the N64, all featuring 3D graphics.**

During this decade also the PC games became mature. The PC was getting a considerable advantage over the consoles. They were much more powerful. Their graphics resolution was better, they had more memory, they had hard disks to store game data, and they had a much higher processor speed. Many great games were produced for PCs, for example *Lemmings*, *Sim City* (by the now famous Will Wright), *Civilization*(by Sid Meier)*, Popoulos* (by Peter Molyneux), *Tomb Raider*, *Quake*, *Half-life*, and *Grand Theft Auto*. Most of these continue to have successful sequels.

PCs could stream video and music from the CD. This led to a new generation of games that relied on good integration of Full Motion Video (FMV) and excellent sound tracks and environmental sound effects. An important example was *Myst* (1993) with it beautiful pre-rendered scenes and atmospheric sound effects. Another example is *Command & Conquer* (1995) that used FMV to tell to story.

Figure 12 *Myst*, *Command & Conquer* **and** *Monkey Island*.

Another advantage of PCs for gaming was that they had a mouse and keyboard. This allowed for games in which the player has to quickly point to locations on the screen, and for games that required many different commands. Real time strategy games, like *Command & Conquer* needed such a pointing device for easy play as did the point-and-click adventures that became popular, like *Monkey Island*. Keyboards were for example crucial in the many complicated flight simulators. Many PCs also had modems, making it possible to play games against people at other locations. This led to the rise of the many massive multiplayer online role playing games (MMORPG), which is still primarily the domain of the PC.

One of the problems of PC games was that it was initially very difficult to install them, in particular when most people were still using DOS. There were always issues with the many different sound and video drivers and it required some expert knowledge from the players about DOS. As a result, games on these devices became something of the nerds; an image that kept hanging around computer games for a long time. It also made the games hard to develop as the developers had to create games that would work on many different specs and different type of e.g. sound cards. Games normally came with a huge collection of drivers to make them work on all these different devices. This all improved considerably when people started to use Windows 95 and in particular when Microsoft release DirectX (1995) which could be used to abstract away from the underlying hardware. It boosted the developments of Windows games.

While console games were played primarily in the living room, PCs were normally located in the study room. This led to a different kind of gamers (often male and slightly older) and a different type of games that were darker and could be played in isolation. In 1993, the game *Mortal Combat* created a huge uprising in the U.S. because of its offensive visuals including the showing of blood. It led to congressional hearings and the start of the discussion about the effect (and banning) of violence in computer games that has not stopped since. It also led to the first official rating system of games (the ESBR).

Figure 13 *Doom*, created in 1993, used fake 3D graphics in software.

There was a drive to create 3D looking games, but most PCs did not have 3D graphics hardware. So extremely clever programmers tried to do fake 3D in software. Probably the most well-known game in this genre was *Doom* created in 1993 by John Carmack and John Romero. It is often considered the first first-person shooter, although there were others before. But it definitely was the most popular one. Although in some sense just a simple maze game, the first-person view, combined with the horror-style

graphics created a very immersive experience and made the game extremely popular. Initially the creators used the shareware model to sell their game and they were extremely surprised by the success.

The success of games like *Doom* also led to an increased interest in 3D graphics cards for the PC. Because of the increased interest prices dropped which in turn increased the sales. As a result more and more games supported these graphics cards which again increased interest. Soon a 3D graphics card became a standard ingredient of a gaming PC. But it was difficult for game developers because they had to create games that would work well on PCs with largely varied graphics capabilities. Developing games for consoles was a lot easier in this respect (and still is).

Also the handheld got a new generation. In 1998 Nintendo produced the Game Boy Color. It was about twice as fast as the Game Boy, had four times as much memory and featured a color display of 160x144 pixels. It could communicate with other devices. An important game that was produced for the Game Boy Color was *Pokémon* in 1998. It was a simplified (Japanese) RPG game. Such games have been popular throughout the world for a very wide audience. The focus is on character development, creating a team, and fighting battles; normally in a separate screen with many different special moves. *Pokémon* added to this an important collecting aspect. Players wanted to collect all the Pokémon in the game. Nintendo created two versions, Red and Blue, and to collect all the Pokémon you had to connect up with somebody with the other version and exchange Pokémon. This became a big hype, supported by trading cards, comics, etc. In the first ten years 140 million copies of the game were sold.

Figure 14 The Game Boy Color and the *Pokémon* game.

2000 – 2009
The next generation of game consoles started just before the turn of the century. Sega was the first to produce their Dreamcast. It was the first 128-bit game console and the specs were impressive for those days: It has 26 MB of memory, it had 32 bit surround sound, and it could display 24-bit colors and could draw up to 7 million polygons per second. Its most popular launch title was *Virtua Fighter 3* and also the various sport titles were very successful. To compete with the online gaming capabilities of the PC it contained a modem. Even though it sold rather well (5 million devices in the first year) this was not enough because the investments had been huge and, as became common those days, the manufacturers actually made a loss on the devices which had to be compensated by the games sales of

which they got a considerable percentage. Hence, Sega decided to stop the production in early 2001 and drop out of the console market. They continued making games for other consoles and still do so today.

In 2000 Sony produced its PlayStation 2. The specs were again much higher. The 128-bit processor had 32 MB of memory and it could draw up to 65 million polygons per second. It had excellent sound qualities, a network adapter and a double layered DVD drive that could also play movie DVDs. The later feature was responsible for quite a lot of the early sales as the PlayStation 2 was cheaper than a normal DVD player. It initially also cost Sony a lot of money because they made a loss on the devices and the people that bought it as a DVD player bought hardly any games. The network adapter made it possible to play online games, but this has never been the PlayStation's main attraction. Microsoft's Xbox was much better in this respect.

The PlayStation 2 was backwards compatible with the PlayStation and, hence, immediately a large number of games were available. Although relatively hard to program, soon a large collection of good games appeared for the devices which was an important reason for its immense success. In total close to 150 million units have been sold.

Nintendo followed in 2000 with the GameCube. They decided though to take a different route and did not focus on specs. The machine was considerably weaker (it could "only" draw 20 million polygons per second) and it did not support DVDs nor did it have Internet connectivity. But as a result it was a lot cheaper and more directed towards the more casual gamers. There were some great games for it, like the *Legends of Zelda* games, *Super Monkey Ball* and *Metal Gear Solid*. But there was not really enough content and, hence, the sales were somewhat disappointing (just over 20 million units).

And finally, in 2001, Microsoft entered the market with the Xbox. It is rumored that Microsoft started their own game console after Sony refused to use DirectX in the PlayStation 2. The Xbox was basically a PC in a console box and was a very powerful machine. It had 64 MB of memory, a DVD drive (but it could not play movie DVDs directly), it could draw 30 million polygons per second and had a hard drive and build-in fast Ethernet. One of the top titles was *Halo*.

The Xbox was in particular good in the online domain. The Xbox Live service offered by Microsoft was a great success. It could be used to see trailers, download demos (to the hard drive) and play online against others. Microsoft had a big advantage in this domain.

The Xbox was too expensive and too late. The PlayStation 2 had already taken the market and there were many more games available for it. Microsoft had to fight an uphill battle. They managed by putting in a huge amount of money but never got even close to the successes of the PlayStation 2. The Xbox sold close to 25 million units. And Microsoft made a total loss on it of 4 billion dollars.

Creating games for the new consoles also became a much more complicated and expensive task. Players (and console manufacturers) demanded increasingly better graphics, movies, great sound tracks, and an increased playing time. Game budgets rose from one to five million dollars per game. This required large teams of programmers, artists, and many more, that were difficult to manage. Many game projects

failed or missed their deadlines. Also many completed games were big failures and the competition was fierce. Quite some companies went bankrupt.

Figure 15 The four new consoles: Dreamcast, PlayStation 2, GameCube, and Xbox.

In the meantime gaming on the PC also developed further. Hardcore gamers preferred gaming on a PC because, with the right investment, the graphics quality of the PC was considerably better than on the consoles. Also certain types of games required keyboard and/or mouse to be played in a comfortable way. However, from the perspective of the producers of games, the PC became more and more of a problem. Because of the wide variety of graphics cards, processor speeds, memory, and peripherals, it became increasingly difficult to create games that worked well on all of them. Developers had to choose between sophisticated graphics that only worked on top-of-the-line machines or more moderate graphics but with a larger potential user group. Game series like *Age of Empires* and *Command & Conquer* went for the second route because they appealed to a wide audience, while for example the FPS *Crysis* (2007) went for the best possible graphics and was primarily directed to the hard-core gamers.

Another problem with PC games was that, no matter what the developers tried, games were easily cracked and copied freely. It became harder and harder to make money on PC games. Also the prices of PC games became considerably lower than those of console games. So many developers stopped developing games for the PC, or published them only considerably later than the console versions.

One PC game that should of course be mentioned is *The Sims* that was first published in 2000 for the PC, and its many sequels. Even though it was developed by the famous Will Wright it was nearly rejected because the publisher could not image that maintaining a family would be fun. How wrong they were. Until now over 70 million units have been sold and new versions and expansions still regularly appear.

Another important development was the rise of the MMORPG games. Of course *World of Warcraft (2004)* is the most famous of these, although not the largest. That prize goes to *Lineage II* that is in particular played in South Korea. But WoW is huge with it ten million players spending many hours a day in the world of Azeroth and together paying more than a billion dollars a year for this.

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Figure 16 Two bestsellers on the PC: *The Sims* **and** *World of Warcraft*.

Another important development was the rise of casual games. Now that more and more households were getting fast Internet connections more and more people started to use the computers that were traditionally not gamers. These people liked to play a completely different type of games that were easy to learn and could be played in short periods of times. This led to the rise of the casual games that were often written in Flash and could be played directly from the website in a browser. Many of them were free, generating revenues through advertisement. A key example was the highly successful game *Bejeweled* (2001). Also well-known card games were played a lot as casual games and a number of arcade games returned, often with largely improved visuals and slightly easier gameplay. Also new genres become popular, like the hidden object games in which the player had to locate certain objects in complicated pictures. With the recent rise of social networking sites like Facebook a new genre of social games appeared in which people have to collaborate with friends in their social networks. A key example is *Farmville* (2009) in which you must manage a virtual farm and exchange good with friends. It has over 80 million active players.

Figure 17 *Bejeweled*, **the hidden object game** *Cassandra's Journey* **and the social game** *Farmville*.

The popularity of handheld gaming devices continued to increase. Nintendo introduced the Game Boy Advance in 2001, with a double screen resolution (240x160 pixels), 16-bit color, eight time the memory and a much faster processor. It was again a big success. Together with the redesigned Game Boy Advance SP over 125 million units were sold. The most popular games were again *Pokémon* games. Then Nintendo made an amazing step. They introduced the Nintendo DS that featured a double screen, something that had never been seen in gaming devices. Also, the bottom screen was a touch screen leading to completely new forms of play. It also had a microphone that could be used for play (e.g. whistling to your dog in the popular *Nintendogs* game of which 23 million copies were sold) and a Wi-Fi connection. Nintendo continued to focus on a wider demographic including women and elder people. This also shows from the highly successful game *Brain Age* (2005), also known as *Dr. Kawashima's Brain Training* in which the player had to solve many math related exercises. The game directed itself explicitly toward elder people claiming that it would keep their brains young, although that was never scientifically proven. But that did not harm the sales. Over 15 million copies have been sold so far.

Figure 18 The Nintendo DS with the games *Nintendogs* and *Brain Age*.

Sony also wanted to get a share of the handheld market and introduced the Play Station Portable (PSP) in 2004. This was a very powerful machine with 32 MB of memory, a screen resolution of 480x272 pixels with full 24-bit color, Wi-Fi connectivity, and video disks that made it possible to also play movies on the device. It was more like a multimedia player for video, MP3, and games. As a result it was also heavy and expensive. The games created for it were similar to the PlayStation 2 but players were not that much interested in a portable device that would play the same games as they could play at home (and for which they had to pay again). Also many of the heavy 3D games are not so well suited to play on a handheld device in public places. A number of versions were produced and in 2009 Sony created the PSP Go that had a rather different design and did no longer use video disks but focused fully on downloadable content, much following the iPhone App Store model. In total over 60 million units of the PSP have been sold.

Also people started to play games on their mobile phones. Initially, screens of phones though were small and the devices were rather limited in their specs. Also they did only have the small phone buttons as

controls. This made it difficult to develop games for them. Added to this came the difficulty that all phones were different. Developers had to create hundreds of version of their games. And selling them was again difficult as this had to go through the telephone companies. Nokia releases in 2003 the N-Gage, which was a phone and a handheld gaming system. Technically the device was good, but the design was rather poor, making it difficult to play games on it. Only 3 million units were sold.

Things changed when the smart phones started to become popular among non-business users. When Apple introduced the iPhone in 2007 this had a huge effect on mobile gaming. The 480x320 screen resolution (on the recent iPhone 4 even 960x640), multi touch screen, and accelerometer made it an excellent device for gaming and challenged the developers to think of new ways of controlling games and new forms of gameplay altogether. But what was the biggest step was the App Store. It allows every developer (and amateur) to create games for the device and sell them through Apple, where 70% of the revenues go to the developer. This made it possible for individuals and very small teams to build up a game development company. No longer were they dependent on the big publishers. The amount of content grew tremendously and prices for games dropped to often just one dollar, completely changing the landscape of mobile gaming. Until now around 75 million iPhones have been sold and close to 10 billion apps have been downloaded for it of which probably halve are games.

Figure 19 The PSP Go, N-Gage, and iPhone.

In 2005 Microsoft started the most recent generation of game consoles with the Xbox 360. This time they did beat Sony who only managed to widely publish their PlayStation 3 in 2007. It was a powerful machine with a tri-core processor, 512 MB of memory, internet connectivity (but Wi-Fi was strangely only an add-on), wireless controllers, and a larger hard disk (except for the cheapest model). It could display full HD images and had a powerful graphics processor that could draw up to 500 million polygons per second.

Despite quite some problems with hardware failure (the infamous red ring of death) the console soon became popular, in particular because it was the only next generation console around and because there were many good titles available. *Halo 3* (2007) was the most successful game for it, selling over 8 million copies. What set the Xbox 360 apart were Xbox Live and the online marketplace. Microsoft also introduce a uniform achievement system for all games with which the player could get points that accumulated to his/her Gamerscore with an online ranking. High score lists always stimulate players to play and by accumulating them over all games this motivation even increases. Up to now around 50 million units have been sold.

Figure 20 The Xbox 360 and its most popular title *Halo 3*.

Sony took the bold move to produce a new console with a blue-ray player. But they had overestimated the speed with which such players would become common. As a result the devices remained way too expensive. Together with other technical problems this led to a long delay in the introduction of the PlayStation 3. They even largely missed to so import 2006 Christmas season and only had the device widely available during 2007, giving Microsoft a huge advantage. The device was also very expensive with a launch price of 500 dollar. The specs though were impressive with even faster graphics than the Xbox 360. But it took Sony a long time to recover and up till now "only" 40 million units have been sold.

Although promised, backwards compatibility with PlayStation 2 games was not very good. Hence, many people continued to buy the PlayStation 2 with the many excellent games that were available. One of the top games for the PlayStation 3 was *Killzone 3* (2009) produced by the Dutch game developer Guerrilla Games.

Figure 21 The PlayStation 3 and the Dutch game *Killzone 2*.

Nintendo decided to go a completely different direction. Rather than opting for more graphics power they decided to aim for the casual market and completely redefined the way to control games with their Wii system that was introduced in 2006. The machine did not even support HD graphics; it did not contain a hard disk and was a lot less powerful. But the controller was revolutionary. Looking more like a remote control, it registered the movement of the player which could then be used to steer the game

characters. Initially there was a lot of skepticism about this and many game journalists predicted it would mean the end of Nintendo, but they were very wrong. With its cheap price and ease of use it soon became the most popular console with more than 75 million units sold. And contrary to Microsoft and Sony, Nintendo actually made a profit on selling the device.

The games produced for the Wii were also rather different, exploiting the new possibilities and introducing many mini-games. Already the bundled *Wii Sports* was a great game to play followed by *Wii Play* of which over 25 million copies were sold. It were in particular the games produced by Nintendo itself that sold very well, probably because they best knew how to effectively use the new interface possibilities and they knew the audience to which the device was targeted. More than 500 million Wii games had been sold worldwide at the end of 2009.

Nintendo continued this focus on casual games and physical interaction with the introduction of *Wii Fit* that came with a balance board that measured your weight distribution. It again introduced a new way of controlling games and tapped into the exercise and health hype. It was again a big success with close to 25 million copies being sold.

Figure 22 The Nintendo Wii and the game *Wii Fit*.

2010 – 2011
Only in 2010 did Microsoft and Sony respond to the success of the control mechanism of the Wii. Sony introduced the Move that had similar (but better) functionality. Microsoft went quite a step further with the introduction of Kinect that measured full body movement using cameras. Although lots of games have appeared for these systems it is still too early to tell whether they are successful. Many of the games concentrate on dancing or fitness but slowly other titles are appearing as well.

Figure 23 The Move and the Kinect system on the left and the game *Dance Central* on the right.

Although the current generation of game consoles is already more than five years old there is still no new generation at the horizon. Only Nintendo has announced its Wii U that is expected to appear in the second half of 2012. The graphics capabilities of the Wii are far behind the Xbox 360 and PS 3 and with the fast adoption of large full HD televisions Nintendo had to create a system with better capabilities. The system will introduce a new controller that contains an embedded touch screen leading to many new interaction possibilities.

Sony and Microsoft are reluctant because of the huge development and launch costs involved. Also, consoles are normally sold below the production price leading to an initial loss that will take a long time to recover. Currently console manufacturers are looking at the cloud for future gaming. In the end it would be cheaper if the games would run on huge server farms and the images would then be streamed to thin clients at the customers. This requires fast broadband and a guaranteed performance, something that is not possible now for a large number of customers but, with the right investment, could become the standard of the future. Whether this will be successful is still doubtful but companies like Microsoft invest a lot of money in it.

Mobile gaming became even more important this decade. The game *Angry Birds* is probably the biggest success with over 100 million downloads. The success of the iPhone is copied by others. Android phones with their Marketplace are now outperforming the iPhone and Microsoft is pushing Windows Phone 7 with its deal with Nokia. In 2012 Windows 8 is expected to appear that will integrate phones, tablets, notebooks, and desktop machines.

Another important development are the tablets, led by the Apple iPad that appeared in 2010 and has already been followed by the iPad 2. Many manufacturers are now producing tablets, most running Android. People expect 2012 to be the year of the tablets with prices dropping considerably. Tablets are also very capable of playing games. With their larger screen and faster processors they are excellent gaming devices. Unfortunately a big legal fight has appeared between the manufacturers about patents and model rights. This might seriously hamper innovation.

Figure 24 Playing racing games on the iPad and Galaxy Tab.

An interesting development of the past two years is stereoscopic 3D. Modern televisions are now capable of displaying 3D images using active or passive glasses. This enhances the immersion in movies and is also very suited for games. So both Sony and Microsoft updated the firmware of their consoles to display such 3D images. Games can render every other frame from a different perspective so adding a 3D experience to games is rather easy. Also the announced Wii U will support stereoscopic 3D. It is still too early though to know whether this will be a success.

Also in mobile gaming people are looking at stereoscopic 3D. But here it is not feasible to require the use of glasses. Nintendo introduced early 2011 the 3DS that uses a so-called parallax barrier. This barrier contains slits such that the left eye sees only half of the pixels and the other eye sees the other half. In this way each eye can see its own picture (but at half the resolution) and, hence, stereoscopic 3D can be achieved. The disadvantage is that the player has to hold the device at the correct position and orientation in front of his eyes. After initial high numbers the sales dropped considerably. But after a considerable price cut in July the device became very popular again. More recently HTC also introduced a mobile phone with a 3D screen, the Evo 3D. More are expected to follow.

Figure 25 The Nintendo 3DS.

Over the past two decades the gaming world has diversified tremendously. We play games on devices ranging from simple mobile phones to dedicated game consoles. Games are played by people of all ages and both genders. We play simple casual games with a low production budget and AAA console games with budgets of close to 100 million dollar. And the number of different game genres has also increased considerably. We spend a lot of money on playing games. In 2010 in the US alone people spend about 25 billion dollar on games. The following chart indicates how this was divided over the different types of games. It is difficult to say how this will develop in the future but the general believe is that it will still grow considerably.
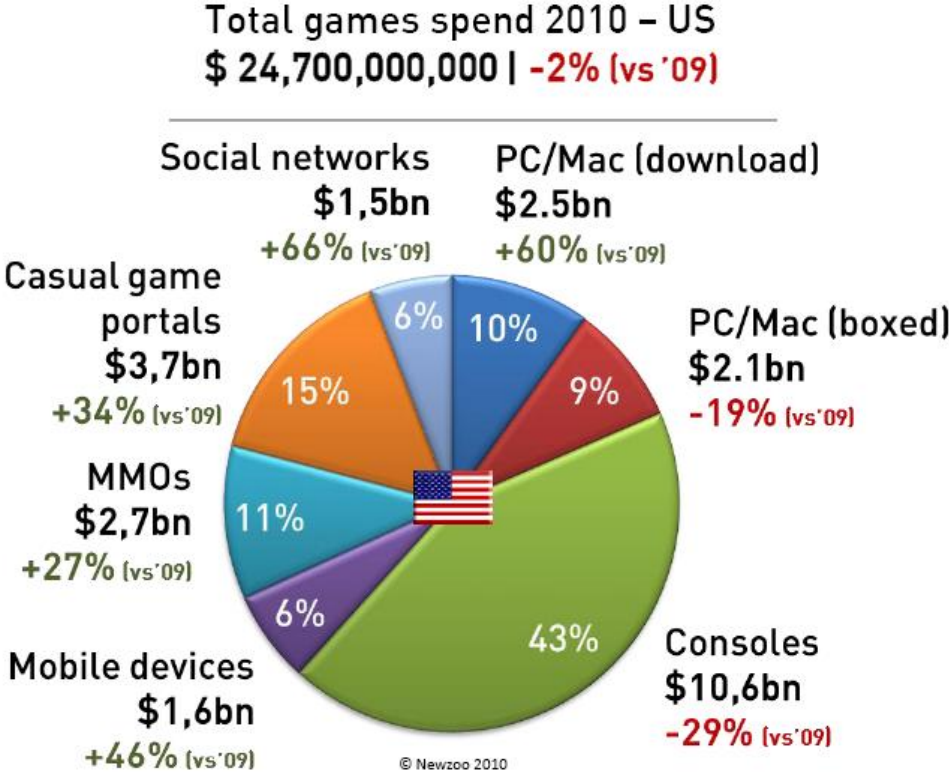

Figure 26 Game expenditure in the US in 2010 for the different types of games. Note the rise for mobile devices and casual/social games and the drop in console games. (source: www.newzoo.com)

Tennis

The changes in hardware, development software, budgets, and experience have changed the games considerably. As an example, let us consider tennis games. Below you find seven tennis games, from the early start of computer games until the recent consoles.
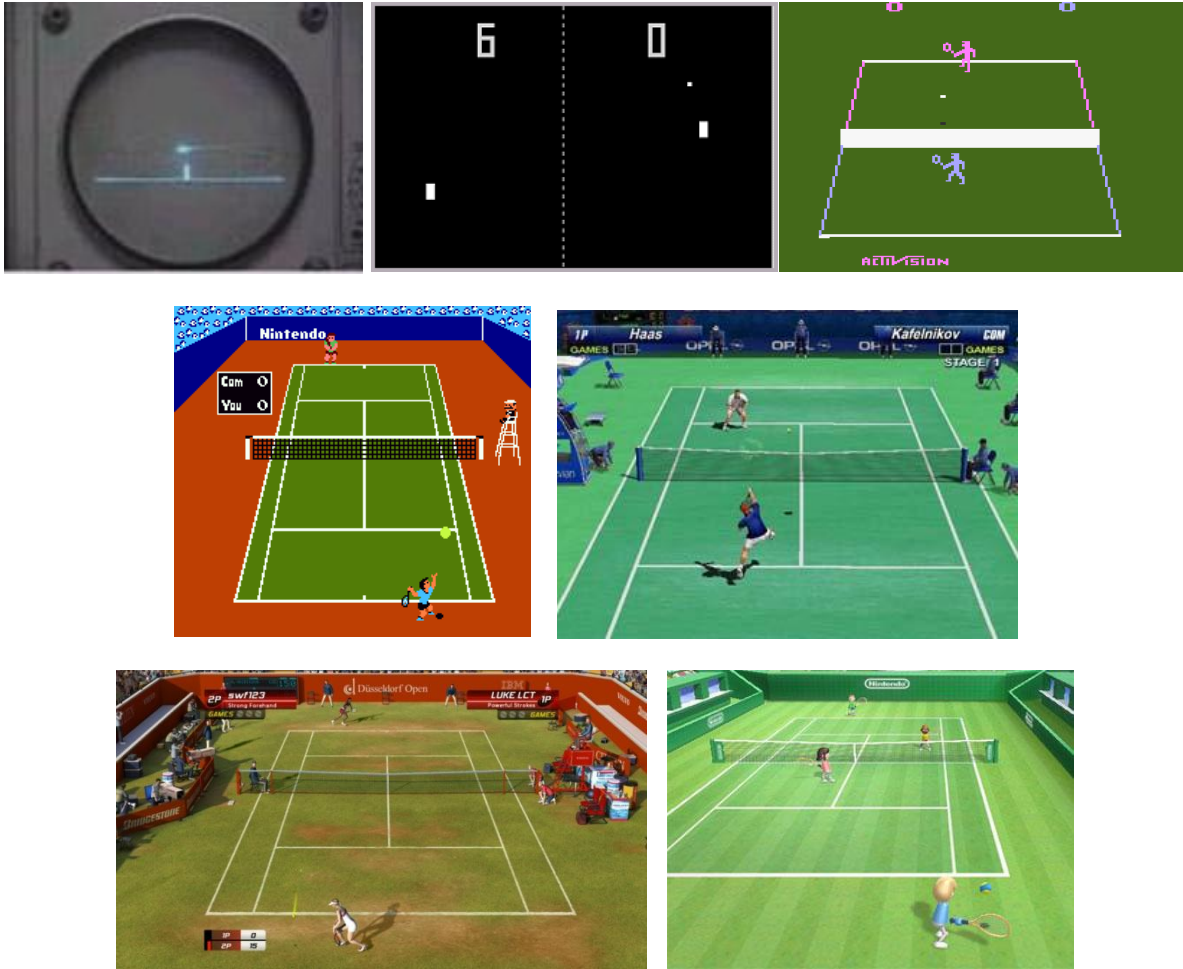
Figure 27 Tennis games throughout the years, from *Tennis for Two* and *Pong* till *Virtua Tennis 3* and *Tennis* on the Wii.

Let us consider the differences between the games.

Graphics. What is immediately obvious is the change in graphics quality. We went from black-and-white to color, we got much higher resolutions, we got many more colors, and we got much better animations. Some games, like *Virtua Tennis,* went for much realism in graphics, while others, like the tennis game on the Wii, went for cartoon characters. The improvement in graphics though not automatically led to an improvement in game play or satisfaction. *Pong* is still a great game to play. And in some of the modern games you feel much less in control because the beautiful but lengthy animations cannot be interrupted. Once the player starts a move you can no longer interrupt it. This is a serious problem that is caused by the animation technology based on motion capture that is used nowadays.

Opponents AI. In the more modern games you can choose from many different opponents. They have different playing styles and a different level. This will lead to more varied play and a better adaptation of the game to the player, leading in turn to a higher satisfaction. The games have a much better learning curve such that players will gradually become better. They do a much better job of keeping players in the "Flow" in which satisfaction is highest.

Storyline and setting. Some more recent games embed the playing of tennis in a bit of a story. You start as a beginner and have to work your way to the top through training and tournaments. You earn money, can buy better equipment and outfits, get to know other players, get famous, etc. This will add an additional motivation to playing the game. Also the setting is much more interesting. You play on different courts, sometimes at exotic locations, leading to additional immersion in the game.

Internet connectivity. Games can now be played over the Internet against other human opponents. This adds a completely new dimension in which the player can aim for being the best in the world. Of course this requires a careful matching system in which players are matched against opponents of about the same strength. Also it requires careful safeguards against cheating.

Interface and control. The interface of the game and in particular the way you control it has also changed considerably: from turning knobs to using joysticks, to using motions of your arms to hit the ball. Also, in later games you can give different effects, control the location of the player, etc. Care must be taken here though to not make the game too difficult to play. For example, in tennis on the Wii you no longer control the location of the player; probably because it made the game too hard.

Changes in Graphics

Probably the most dominant change in games over the past 50 years is the change in graphics. The first game devices were very limited in their graphics capabilities. The graphics was drawn in an analog way, that is, the beam of the TV screen was directed to the correct positions and there it was turned on to display a dot. This technique was later refined into what was called vector graphics, where the image was drawn with the beam on the screen. The advantage was that the lines were very sharp, but areas could not be filled and the devices could draw only a limited number of lines.

Figure 28 Vector graphics in the 1980 game *Battlezone*.

Once the devices were able to store the screen image in a bitmap the possibilities increased rapidly. Resolution initially was very small though. The Atari 2600 had a resolution of 192x160 pixels. This has quickly improved and nowadays games can be played on PCs on resolutions of 1920x1280 or higher. Color depth started with 4 simultaneous color on the screen (out of a larger pallet) to the 24bit color that is common nowadays (256 shades of red, green and blue).

Initially the standard way to draw objects on the screen was the use of sprites, together with some background images. Sprites are small bitmaps that are partially transparent. By changing their location on the screen objects will move around and by showing slightly different sprites in quick succession you get an animation. Consoles had special hardware to quickly draw sprites. Some could even draw sprites at a higher resolution or with more colors than the background image.

Even though many games nowadays use 3D graphics, sprites are still very common in Internet games, casual games, and games for mobile devices. They require cheaper hardware, look better on low resolutions because they are hand-designed rather than generated, and they take less work to create than 3D models. Because on current hardware sprites can also be scale, rotated and blended, the visual effects that can be achieved are very good.

Figure 29 A sprite set for a character.

Soon developers wanted to create 3-D looking games. Because real-time 3D was still completely impossible they used a number of tricks to give the impression of a 3D image. Parallax scrolling was using in which images in the background move slower than images in the foreground. This gives the impression that they are further away. Some geometric drawing was used to e.g. make a road get narrower in the distance. And they used sprite scaling and/or sprites of different sizes for objects at different distances. This technique has been used for many years.

Figure 30 Fake 3D in the game *Outrun* (1986). The sprites of the palm trees and cars are scaled depending on their distance and drawn from back to front. Parallax scrolling is used for the clouds in the back, and the road is drawn with geometric primitives.

A very important development in game graphics was the use of isometric projections. In an isometric projection we look at the game world under an angle of 45 degrees. We project the game world on the screen but do not apply a perspective correction. As a result, the projection of an object on the screen has the same size, independently of where it is located in the game world. This is exploited by using sprites for the projection of the objects. By keeping the view fixed, that is, only shifting it but not rotating it, the objects will always look the same and the same sprite can be used.

Isometric projections give a strong suggestion of depth. Even though they are incorrect and suffer from perspective distortions, this is acceptable when the view is from a distance. They are particularly useful when the user needs an overview of a considerable part of the game world, like in strategy games. This type of view has become so common that current RTS games still use it, even though the image is drawn with true 3D graphics.

Figure 31 The difference between a top-down view and an isometric view in the first two releases of *Civilization*.

In the early nineties developers took the first steps to real 3D graphics. Because of the capabilities of the machines they were very limited though. All calculations had to be done in software. These early games, like *Doom*, used a 2D game world in which the player moved around. But when it came to drawing the image, the 2D wall segments were replaced by projected vertical walls with a texture. For the other objects and characters, still sprites were used that were scaled and rotated in the direction of the player. So you would see the characters always from the front (in this way reducing the number of sprites required). Even with all these limitations, the effect was amazing and led to a huge immersion in the game world.

Figure 32 2.5 D graphics in the game *Wolfenstein*.

In the second half of the nineties, things moved quickly. 3D hardware became common in console and PCs. Due to a severe competition between the creator of the graphics cards the speed and possibilities increased rapidly. New techniques for shading, texture mapping, reflections, shadows, and shaders, often designed at universities, quickly found their way in the graphics cards and were exploited by the game developers. Beautiful 3D graphics became the norm for all big game titles and used up millions of development budgets.

Unfortunately, the behavior of the characters in the game world did not improve as quickly because the budgets spend on for example AI were a lot smaller. As a result the games became unbalanced, destroying the so important "suspense of disbelief". When the player sees very realistic graphics he/she expects also very realistic behavior. If this behavior is not there the game world starts to feel fake. Fortunately, new graphics techniques make it possible to give characters and worlds again more of a cartoon view, where players no longer expect realistic behavior.

Figure 33 Cartoon shaders in *Prince of Persia* create a special graphics style and allow for cartoon-like behavior.

The wish to create even more realistic graphics continues. One of the reasons is that games tend to sell based on their visuals and not based on their game play. But game companies nowadays realize that game play and AI are equally important aspects of games.

Figure 34 Realistic 3D graphics in *Crysis 2* that appeared in 2011.

In 2011 we saw the next big step in game graphics: 3D displays. Using active shutter glasses or passive polarized glasses we are starting to get used to seeing true 3D movies in cinemas. During 2010 the first TVs appeared that could also display such 3D movies and now the game consoles follow with producing true 3D games. And Nintendo introduced its 3DS in 2011 which does not even require special glasses for a 3D view.

Technically it is not so difficult to create games for these devices; you just generate two images from slightly different viewpoints, rather than one. But it is still unclear whether the experience is in the long term as satisfying as the developers hope. It might simply be too tiring for the eyes. And even though people like an immersive game play experience, it is known that the experience should not become too immersive. It is important that the player always knows that it is not real.

Changes in Interaction Devices

The game play experience is very much dependent on the devices the player uses to control the game. A great game with the wrong controls is often frustrating to play. This can for example be seen from some console games in which you need to move through multiple levels of menus to give commands or need to use a joystick to point at locations.

The controls have changed considerably over the years. When games were used in the arcade the controls were specially build for the game. In this way the experience was often best. For example, a rotating knob remains the better way to control a *Pong* game. Controls in arcade machines became increasingly sophisticated, including complete cockpits and car dashboards.

On game consoles on the other hand the controls were limited and all games had to use the same controls. Initially they consisted of a joystick (or knob) and one or two buttons. This was enough for the simple arcade games but became too limited for more complex games. Slowly the number of buttons and other elements on the controllers became more complex, introducing joysticks, multiple buttons, and the directional pad (or D-pad). Although this helped to control the games, it also became more and more complicated to use the controllers, in particular for new and casual gamers.

Figure 35 Evolution in controllers: NES, Super NES, N64 and GameCube.

On the PC the situation was rather different. Of course all computers had a keyboard, making it easy to give many different controls. Arrow keys (or others) could also be used as a directional pad. On the other hand most computers did not have joysticks and initially they also did not have a mouse. To play certain games, such as flight simulators or racing games, you had to buy a separate joystick or a special steering wheel. Also these became increasingly complex and difficult to use with up to four axis and

many programmable buttons. Such controllers also started to include force feedback that creates a counter force when you for example move through a sharp corner. This considerably enhances the experience and actually also makes it easier to control the device as you can feel what is happening.

Figure 36 Complex joysticks and steering wheels.

The mouse that became common with PCs was an especially interesting device. It allowed for very precise point, selection and drag-and-drop. This was particularly suited for certain games genres, such as point-and-click adventures and real-time strategy games, both of which have only limited success on the consoles. In *Black and White* they even went so far as to use the mouse to give commands by drawing symbols. Although a nice idea, it was not very effective as it took more time and you easily made mistakes.

During the past decade we have seen many new devices being used. Microphones were used for communication with other players (for example over the Internet) but also for voice control, and more recent even for Karaoke in games. Cameras, like the Eye-toy of Sony, were employed to recognize motion that could be used to steer the game (in a limited way). Devices even started to appear that were specially built for a particular game, such as buttons for a quiz game, dance mats for *Dance-Dance Revolution* and guitars for *Guitar Hero*. This added an important additional element of emersion to such games. In some sense we got back to the specially built devices for the arcade machines.

An important step was made by the Nintendo Wii. Nintendo decided that the controller of console games had become way too complicated and wanted to attract a new audience of players. Their controller looked like a remote control with a few buttons, which registers your motions when you wave it through the air. People were very critical when they announced it and many believed the Wii would mean the end of Nintendo. How wrong they were. By focusing on experience and ease-of-use the Wii became the most popular console of the new generation. Only in 2010 Sony and Microsoft finally followed with the Move and Kinect, respectively. The Move basically has the same functionality as the Wii controller but with more precision (and technically rather different). Kinect on the other hand, uses

full body motion capture, and does not require a controller at all. The system can not only register motions of the hands but of all body parts, allowing for completely different game play. It is though rather expensive and requires a lot of space to use. It will be fascinating to see what type of games that will lead to.

Figure 37 Nintendo Wii, Sony Move, and Microsoft Kinect.

New devices are bound to appear in the future. The Wii U that appears in 2012 will have a controller with a touch screen, such that games can define their own interface. And we can already measure heart rate or arousal using devices. And there is a lot of research being done into brain-machine interfaces where we try to directly read the brain signals to steer computers. It could lead to a control mechanism in which you only need to think to steer the game.

Changes in Demographics

The first computer games were played in the arcades. These were traditionally visited by young males, and, hence, that was the first audience for games. As a result, also most people working in the game industry were young males. When the first game consoles appeared in the homes, everybody could play them. But due to the nature of the games, which were largely copied from the consoles, the prime audience remained young males. This continued when new generations of consoles appeared.

When PC gaming started, computers were still primarily used by men. It was also difficult to install and play these games, required knowledge of the operating system of the computers. Only few women had this knowledge or the interest in it. So again, primarily men played these games. However, the age range became a bit larger because computers where primarily owned by a bit older men. This can be seen in the type of game, such as the flight simulators and adventure games like *Myst* that were directed to a more mature audience.

Things started to change though. Hand-held devices, like the Game Boy, were used by (young) kids of both genders. This required from the game industry to develop games that attracted a younger audience. This change is clearly visible when you look at the games produced for the Game Boy that have cuter characters and less graphical violence (although games like *Pokémon* are actually very violent in nature). But it was still primarily the youngsters that played games.

This changed when the Internet started to become popular. Suddenly, the computer became the tool of everybody; young and old, and male and female. This opened a complete new demographic and, hence,

new business opportunities. The male dominated business though did not really know how to respond to this. For the game *The Sims* that had been a huge success with equal numbers of players of each gender, initially no publisher could be found because they could not imagine that a game about managing a family would be successful. And many attempts turned to the clichés of pink colors and horses.

An important next step was the rise of the games that could be played on the Internet, directly in a web browser. These so-called *Casual Games* did not require any installation and were very easy to play. Games often last only a few minutes, making it possible to play them at irregular intervals and briefly in between other tasks. This attracted a complete different audience, in particular middle-aged women. In many ways these casual games have similar features as the original arcade games (easy to learn, difficult to master, simple controls, and short duration) that got the male population into gaming. A recent next step was the introduction of *Social Gaming*, through sites like Facebook. In these games it is crucial that you have and maintain a large social network as this helps you in progressing in the game. It drives the number of people playing games up because of the social pressure that is created to join and help your friends.

Nowadays, almost the whole population plays computer games, as the following charts show. In the U.S. even of the people above fifty more than 70% of both men and women play games and they spend an average of over five hours a week on it (with women playing more than men). It definitely shows that something has changed. But the industry continues to be dominated by men and still has trouble in creating enough interesting content for women. But that is bound to change as well in the near future.
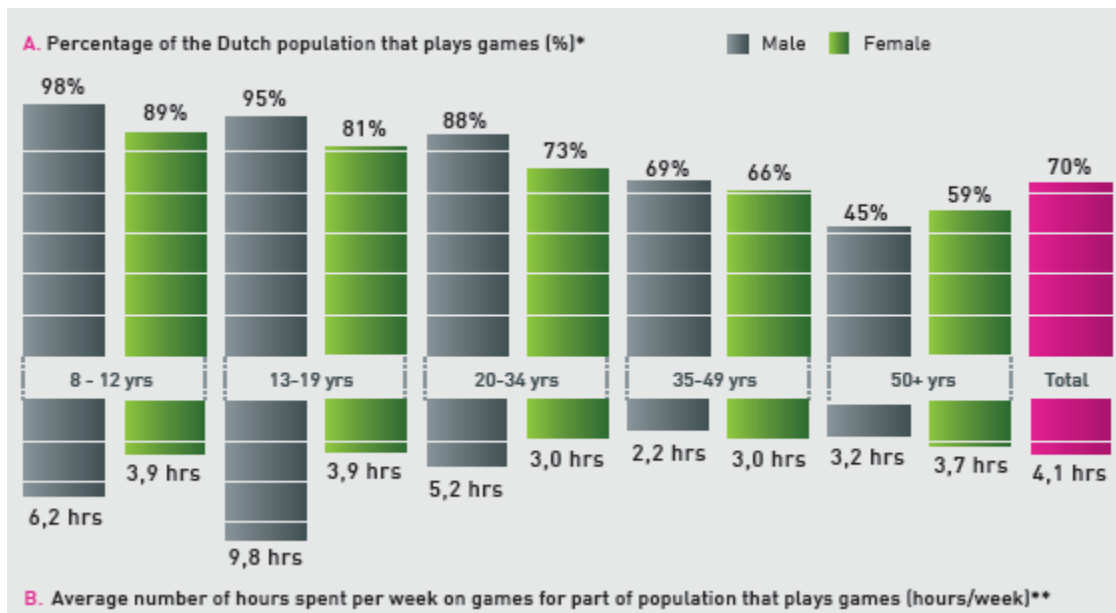

Figure 38 Percentage of Dutch population playing games and time spent in 2009. (source: www.newzoo.com)
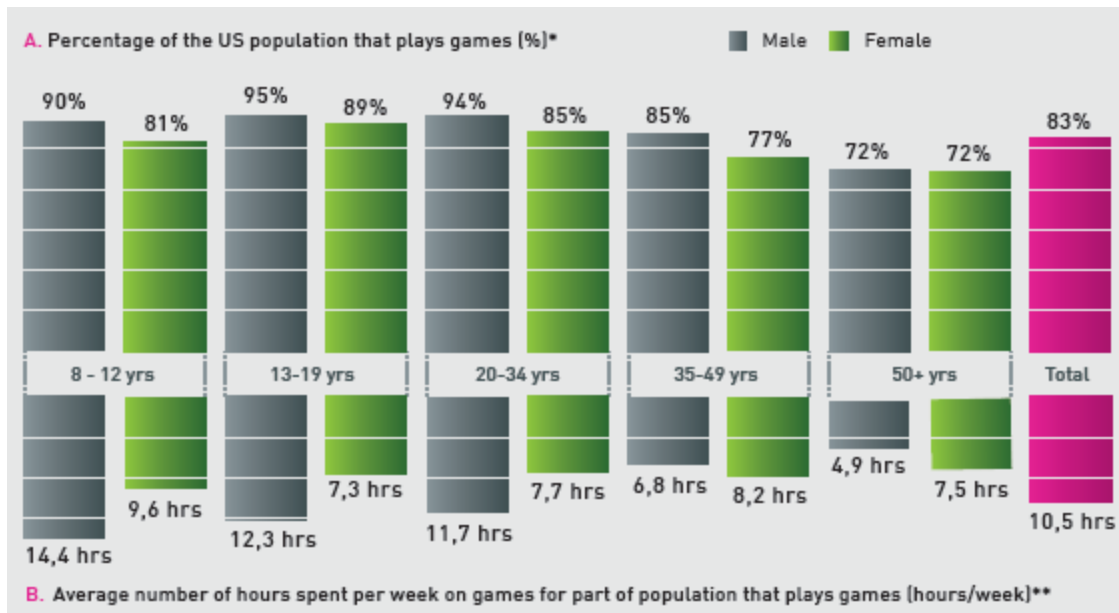
Figure 39 Percentage of US population playing games and time spent in 2009. (source: www.newzoo.com)

Changes in Gameplay

Over the past 50 years, not only the gaming hardware developed but also the game play changed considerably. On one hand this was due to the changes in the possibilities of the hardware, but it was also caused by an improved insight of game play. Many of the game play concepts that you learn in this course where discovered over the years, often by trial and a lot of error.

Initially, games were played on arcade machines. For the makers of these machines it was crucial that players would put as many quarters in the machine as possible. Hence, games should be brief, and players should be stimulated to play again when they failed. Also, they should never have the feeling they completed the game. This led to a number of game design issues. There was no time for an extensive introduction in the game. So it should be very obvious how to play the game, and the controls should be really simple. Games quickly became very difficult to make the play time short. It was important that the player always had the feeling that he could have done better such that he would play again. Some games used the trick that you could continue the game where you lost if you put in another quarter within 10 seconds. Otherwise you had to start from scratch again. (Strangely enough some early PC adaptations of the games did the same. You had to press a button within 10 seconds to continue the game; something that did not make any sense in the setting of playing on a PC.)

This led to the now well-known type of arcade games where the focus is on reaction speed and fast-decision making. An adrenaline rush is the drive to continue playing. Initially you played against the machine. Only in 1976 the concept of high score lists was introduced (in a game called *Sea Wolf*), later expended with the initials of the players. Now you not only played against the machine but you also competed with other players on the machine, adding an additional drive to play. (When games were moved to the console and PC the designers of course copied the high score lists, even though they are

way less important because normally only very few different players play on the same PC. Only now that we can store high scores on the Internet, they again get their early meaning.)

Slowly other game design concepts were introduced. In 1979 the first game was created with different levels and a boss enemy (*Ozma Wars*), in 1980 *Carnival* for the first time featured a bonus round, and in 1981 *Tempest* introduced a selectable difficulty level. Early games never ended (at least not for a mortal), you simply died at some stage. It took until 1984 to have a game with an ending (*Marble Madness*). Also new game genres appeared. For example, the first platform game, *Space Panic* only appeared in 1980.

A huge change came about when games got played on devices that could store game data. Now games could become a lot more complex because people could spend multiple sessions on playing a game. Games could consist of many levels and the player could be guided to gradually more complex tasks. The time it took to complete a game changed from a few minutes to many hours. Nowadays quite some games you basically play only once (or twice to get all the achievements). The introduction of CD drives and DVD drives gave the developers way more storage so they could tell complicated stories with pre-rendered graphics, movies and spoken text. The story suddenly changed from a back story (on the back of the cover) that just motivated the player to buy the game, to an integral part of the game itself.

The Internet led to games that were much more based on competition with large communities of players. It also led to the MMORPG games where many players act in the same game world. New interaction devices also led to new game play concepts, like the point-and-click adventures or the motion-controlled games of the past few years. New demographics made game designers think about what drove other audiences, leading to more social and collaborative games. This development is clearly not finished. In the years to come we are bound to find new forms of game play.

Changes in Business

Game companies have also changed over the years. In the early days games were often created by individuals who did the game design, programming (in Assembly language) and the art (which was rather limited). Because the programming was the most difficult part, initially games were primarily designed by programmers. A game typically took a few months to create and the budgets were minimal.

However, when the industry started to grow so did the development teams and the budgets. Nowadays, big AAA titles are created by teams of over one hundred people and the budgets are tens of millions of dollars. Risks are very high, and, as a result, publishers tend to stick to proven game concepts and IP from popular movies. Hence, we see a constant flow of sequels and look-a-likes with little creativity. All effort is put into making the games visually more attractive to stand out amidst the competition, while little effort is put into creating interesting and original game play.

Game production studios have become very dependent on the publishers. Because of the high cost of the development of games they cannot finance it themselves. Hence, they depend on the publishers to provide them with the budgets to produce the game, giving the publishers a lot of influence on the game. Without a good publishing deal it has become almost impossible to produce a console title.

Fortunately, things are slowly changing again. Besides the big console titles we now see a big growth in smaller games for smart phones, tablets and other mobile devices. They can be created with relatively low budgets and small teams and you can self-publish them through e.g. the App Store, Android Market Place or PlayStation Network (although some approval from the platform owners is still required). Because the publishers and retailers have been removed from the chain the percentage of the revenues has increased considerably (like the 70% that Apple gives you). This altogether makes a game profitable much more easily. On the other hand, the competition is huge and it is difficult to become visible on the App Store. And visibility is everything; without it your game won't sell at all. So in the end you might need a publisher after all, just to give your game enough visibility.

Also new business models have appeared. While originally the companies made money purely from the sale of games, nowadays there are different options. For example, the business model can rely on in-game advertisement or in-game purchases of good that help the player play the game (often referred to as Freemium games). This gives more opportunities for new companies to enter this fast-growing market.

Further Reading

If you are more interested in the history of computer games, there are a number of books that you might want to read:

- Kate Berends, Geoff Howard. *The Rough Guide to Videogames*, Rough Guides, 2008. ISBN 978-1-84353-995-7.

- Bill Loguidice, Matt Bartson. *Vintage Games*, Elsevier, 2009. ISBN 978-0-240-81146-8.

- Steven Kent. *The Ultimate History of Video Games*, Three Rivers Press, 2001. ISBN 0-7615-3643-4.

If you want to know more how game designers worked in the early days of computer games, you might want to read the second part of the following book by Chris Crawford, in which he described the various games he designed.

- Chris Crawford. *On Game Design*, New Riders Publishing, 2003. ISBN 0-13-146099-4.

Also I recommend you to read the following great book about how the game *Doom* got created.

- David Kushner. *Masters of Doom,* Random House Inc., 2003. ISBN 0-7499-2489-6.

There are quite a number of websites devoted to the history of computer games. Here are some you may find interesting:

- www.emuunlim.com/doteaters/index.htm. Gives a description of the early developments of computer games until around 1985.

- www.videogamecritic.net. A site with brief reviews and images of many of the games produced for the various consoles, ranging from the Atari 2600 to the PlayStation 3.

- www.gameinnovation.org. Interesting site with an overview of many gameplay innovations and the first games that used them.

- http://en.wikipedia.org/wiki/History_of_video_games. This Wikipedia article with the many sub-articles gives you a wealth of information about the history of video games. This includes descriptions of all the different consoles and many of the early games.

Assignments

We conclude with some voluntary assignments. They will give you further insight in the development of computer games over the past fifty years and how these developments have led to the current situation. You are strongly encourages to make some of the assignments. They are pretty open such that you can spend as much or as little time on them as you feel appropriate.

1. Consider the following game consoles: Odyssey, Atari 2600 (VCS), Nintendo Entertainment System (NES), Nintendo Super NES, Nintendo N64, GameCube and the Wii. For each of these, use the Internet to find out the processor speed, amount of internal memory, graphics and sound capabilities, and type (and size) of the medium on which the games are distributed.

2. Do a similar comparison as in the previous assignment with the three most recent consoles: The PlayStation 3, the Xbox 360, and the Nintendo Wii. Consider some games that appeared on all three the consoles and, using images and reviews from the Internet, compare them. Also consider the differences in interaction technique. Finally, find out some figures about the commercial success of the three consoles.

3. Of the *Final Fantasy* series of games up to now 13 episodes have been produced. The first one was published in 1987 and the thirteenth in 2009. Using images and reviews from the Internet (and maybe playing some) compare the different episodes on aspects like graphics, gameplay, interaction, and the role of the storyline.

4. The game *Pro Evolution Soccer* (or *PES* for short) has been published yearly since 1993 by Konami. Check out a number of versions using images, descriptions, and reviews from the Internet and compare them on aspects like graphics, gameplay, and interaction. Alternatively, you can look at the game *FIFA Soccer*, or *FIFA* for short, that also appeared yearly since 1993. You can also try to compare the two games over the years.