



## D I P L O M A R B E I T

### HISTORY OF ELECTRONIC GAMES

### AND AN INTERACTIVE INSTALLATION AT THE 'TECHNISCHES MUSEUM' IN VIENNA, AUSTRIA

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durch

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# 1 Introduction

## 1.1 Motivation

During the last few years, there has been an increased interest in so-called “Retro-Gaming”, i.e. the hobby of playing older electronic games, either on the original hardware or by using emulation software on modern computers. Classic games like *PONG*, *Tetris* or *Pac-Man*, even though they are technically vastly inferior to modern games, enjoy new popularity today.

There are several reasons for this new interest in old games. One is that the generation that experienced the first electronic games during their young adulthood is now grown-up and likes to remember the feelings they associate with such games. Another reason is that many people feel that many of today’s games are actually less interesting than classics – depending on one’s taste, a game of *PONG* can be more fun than the most advanced multiplayer First-Person Shooter. A third reason may be that electronic games have become an important part of popular culture and are regarded as more than just toys. They are both a form of art and a medium; they can tell stories and communicate values and ideas. Studying them raises questions about social and cultural aspects of gaming and about what actually makes games fun to play.



Picture 1: Classic games in popular culture: A *Space Invaders* T-shirt and a *Pac-Man* hat

This thesis is about the history of electronic games and about an installation which was made for the exhibition „medien.welten“ at the „Technisches Museum“ (Museum of Technology) in Vienna.

## 1.2 Terminology

A *game* is a pursuit or activity with rules performed either alone or with others, for the purpose of entertainment and/or competition.

An *electronic game* is a game in which electronics are used for establishing the game framework and enforcing game rules. For example, pinball is not an electronic game (even if it has flashing lights and sound effects), because electronics are not the primary focal point of the player; they merely support the presentation of the game. In most electronic games, the actual goal and challenge of the game is established by electronics (i.e. the human plays against the computer), although in some electronic games multiple humans can compete against each other (multiplayer games).

An *arcade game* is an electronic game played at arcades (i.e. establishments for the purpose of entertainment). It is coin-operated, runs on dedicated hardware and usually involves a display similar to a television screen and simple input devices such as joysticks.

A *video game* is an electronic game played on a video game console.

A *video game console* or *home console* or *game console* or simply *console* is a dedicated electronic device specifically designed for playing games. It is typically attached to a television set and uses input devices similar to those found at arcade games. Consoles either have one or more built-in games or load games from external storage media (e.g. CD-ROMs).

A *handheld console* or simply *handheld* is – similar to a home console – a dedicated electronic device intended for playing, but small and light enough to be used while holding it in hands. It is battery-operated and can be used without additional devices, i.e. controls and display are both part of a single unit.

A *computer game* is a game played using a general purpose computer and may involve a variety of audio-visual presentations and input devices.

A *multiplayer game* is an electronic game in which multiple humans play in a concurrent manner (either cooperatively or against each other). Multiplayer usually refers to networked play (i.e. every human plays on his own computer or game console), although some multiplayer games exist which can be played on a single machine using techniques such as split-screen.

## 1.3 Overview

Early experiments and attempts to create electronic games date back to the 1940s, but they did not become part of popular culture until the 1970s, when both home consoles and arcade games became available to a mainstream audience (chapter 3), introducing classics such as *PONG*. The popularity of arcade games reached a peak around 1980 in the so-called Golden Age of Arcade Games (chapter 4), when *Pac-Man*, *Space Invaders* and other highly successful games were made. At about the same time, a wide range of home consoles entered the market, trying to bring the popular arcade titles to the television screen at home (chapter 5). Then, after a few years, a decline of the game industry set in, caused by over-saturation of the market and lack of new ideas (chapter 6). Instead, people seemed to have developed a new interest in home computers such as the Commodore 64 (chapter 7), which turned out to provide fresh impulses for electronic games. In 1985, home consoles also regained their popularity with the introduction of the NES (chapter 8). However, the most versatile and long-lasting device ever used for electronic games was neither a home console nor an arcade game. It was the PC, which was introduced in the 1980s and made enormous contributions to the evolution of electronic games (chapter 9).

Chapter 10 gives an overview over handheld consoles, their games and their influence on game history.

Chapter 11 outlines some popular game genres and notable representative games.

Chapter 12 describes some recent developments and current issues in modern computer and video games.

Chapter 13 gives a timeline and chart, outlining the most important events in electronic game history.

Chapter 14 provides a list of “high scores”, i.e. games with very outstanding features and games pioneering innovative new ideas.

Chapter 15 describes an installation made for a museum in Vienna, Austria, designed to illustrate the history of electronic games.

Finally, in chapter 16 conclusions are drawn, and in chapters 17 and 18 an index and a list of references are given.

## 2 Before Electronic Games

The birth of the first electronic games was arguably inspired by the concurrence of technological evolution of hardware and various already existing ideas from the entertainment industry as well as sports. Many of the very first games (e.g. *PONG*) were simulations of sports or other familiar activities, which made it easy for new players to understand the idea and objective of the game.

Pinball games are often credited with having contributed to the invention of electronic games. The first electric pinball game named *Contact* was built in 1933 by Henry Williams. Pinball involves a ball, a board, scoring, and buttons which to some extent resemble the interactions found in early electronic games. Another characteristic of pinball games is that it is not possible to win them, only to try to play as long as possible. These traits could also be found in the earliest electronic games.



Picture 2: The first pinball game „Contact“, 1933

Another source of inspiration for computer games was the military, in two ways: First, electronic hardware used in World War II already performed functions which resembled elements found in early games (e.g. computers were used for radar displays or for ballistic calculations of missile trajectories). Second, there has always been a relation between the concepts of game and war in human history. Some wars are fought bound by mutually-agreed rules, and sometimes games are played with a highly aggressive and competitive spirit. Playing a game – like fighting a war – is always a form of competition, in which the player (or the combatant) tries to maximize his advantage over his opponents. Throughout the history of electronic games, military themes have repeatedly influenced games (e.g. one of the first games, *Space-*

*war!*, is a simulation of a battle between two spaceships), and violent games often proved to be among the most successful.

So it can be said that the emerging availability of suitable computer hardware, together with some already existing ideas from other fields, the human drive to play and experiment, and the creativity of a few people lead to the creation of the first electronic games. Later of course, games experienced an impressive evolution, were technically improved, enriched with many more features, and eventually evolved to how we perceive them today.

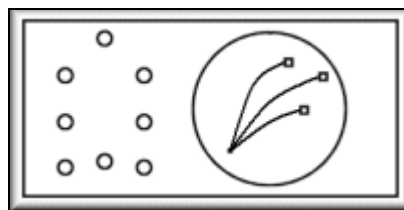
### 3 The First Games

#### 3.1 *An Unnamed CRT Game*

In 1947 a United States patent was filed by Thomas T. Goldsmith Jr. and Estle Ray Mann for a “cathode ray tube (CRT) amusement device”. The system used eight vacuum tubes and simulated a missile being fired at a target, probably inspired by radar displays used during World War II. Several knobs allowed adjusting the curve and speed of the moving point representing the missile.

The game was not named by its inventors. However, it already had the core features every game must have: a display, user input, and an objective.

The display of the game was composed of small targets drawn on a simple overlay which was placed on the CRT. Since no electronic video signals were generated, it is not considered to be a real video game. Furthermore, the underlying hardware consisted only of simple electronic elements and circuits; too simple to be called a computer. However, it is believed to be the earliest electronic system specifically designed for playing a game.

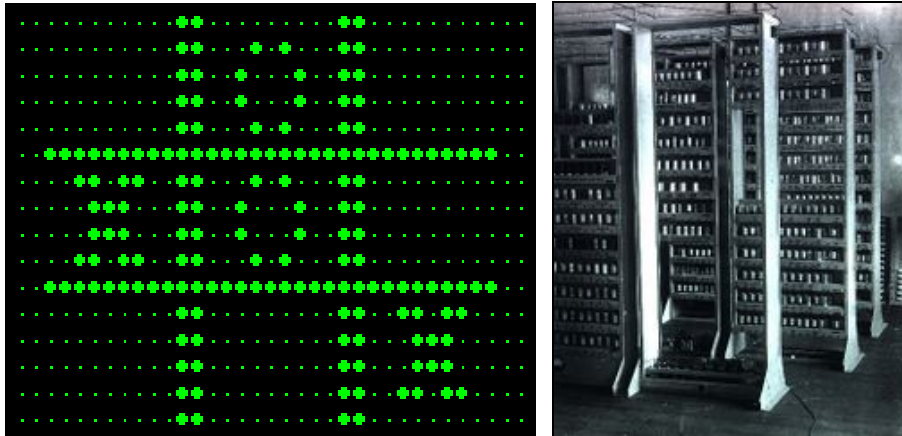


Picture 3: Schematic view of an early electronic game, 1947

#### 3.2 *OXO*

The first game to use a graphical display was *OXO*, a simulation of “Tic-Tac-Toe”. It was created in 1952 as part of a PhD thesis on the topic of “Human-Computer interaction”. The computer used for this game was EDSAC (Electronic Delay Storage Automatic Calculator) at the University of Cambridge in England. It was able to play a perfect game against a human, i.e. it never lost and won whenever possible.

The display was organized as a matrix of 35 by 16 dots on a cathode ray tube. Input was done via a punched tape and a dial pad as used for telephones.



Picture 4: *OXO* (1952) and the EDSAC computer

*OXO* was the first graphical computer game known to exist.

### 3.3 *Tennis for Two*

Another early computer game was *Tennis for Two*. In 1958, William Higinbotham, an employee at the „Brookhaven National Laboratory“, created this game in order to attract people at visitors' day. His intention was to show the capabilities of an analogue computer in combination with an oscilloscope with a cathode-ray tube. A two-dimensional, side-view of a tennis court was displayed on the oscilloscope, and the objective was to bounce a ball back and forth.

Although this game was never mass-produced, never earned any money, and was only available for two years in Higinbotham's laboratory, it attracted the attention of many people.



Picture 5: *Tennis for Two* (1958)

It is believed that the inventor of *Tennis for Two* was not aware of earlier computer games. Neither did he understand the implications of his creation. No patent was filed and no attempt

was made to further pursue the idea of creating games, because Higinbotham did not believe he invented anything at all.

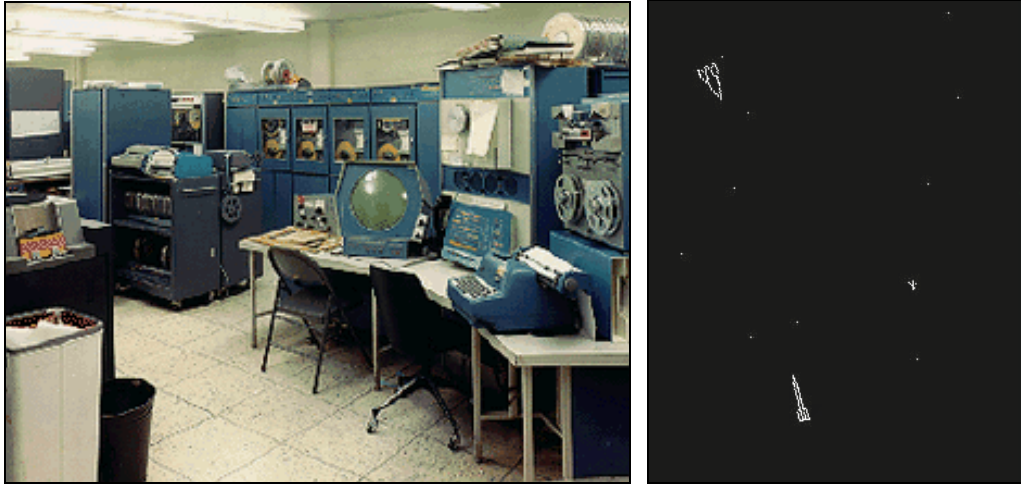
### **3.4 *Spacewar!***

Some people, however, claim that an oscilloscope is no real computer, and therefore, another scientist named Steve Russell is sometimes credited with the invention of the computer game. Russell was a programmer at the Massachusetts Institute of Technology (MIT), which in the 1960s was the center of the computing universe. He was working with a new computer called PDP-1 (Programmable Data Processor-1) and, driven by his fascination for the modern hardware, was determined to explore its possibilities by writing a demonstration program, which should fulfill the following requirements:

- It should demonstrate as many of the computer's resources as possible, and tax those resources to the limit;
- Within a consistent framework, it should be interesting, which means every run should be different;
- It should involve the onlooker in a pleasurable and active way – in short, it should be a game.

Russell further reasoned that in order to make the game interesting, it should involve some kind of contest or fight, and since one of his main personal interests was science fiction, he ended up with the game *Spacewar!*, a battle between space ships with a few rules, limited resources like fuel and rockets, and some other simple features. He started working on that game in 1961 and finished it in 1962.

That means Steve Russell was the first who went through a process of actually thinking about how to make a game interesting for players. In the years and decades to follow, that process would become much more complex and eventually be called game design.



Picture 6: The PDP-1 computer and *Spacewar!* (1962)

As a side-effect of working on *Spacewar!*, Russel and a few colleagues also created an alternative input device for the PDP-1, a kind of remote control with specific buttons for *Spacewar!* functionality (e.g. for firing weapons or activating hyperspace). This could be called the fore-runner to the later gamepads.

Russel's game immediately received a great amount of attention at the MIT. It was eventually shipped with every PDP-1 computer for free, and its manufacturer Digital Equipment used it as a diagnostics program. In the end however, with the PDP-1 being very expensive, the game became available only to very small number of people.

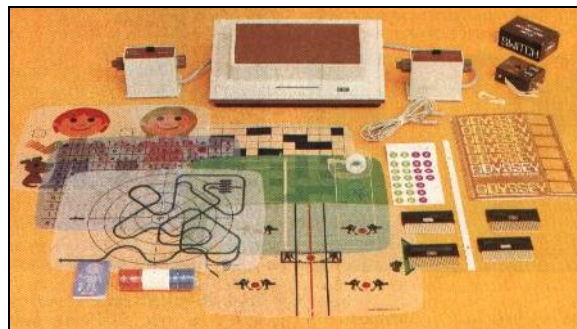
### **3.5 The First Video Games**

So far, the first computer games relied on unique or expensive hardware and were not available to the public. However, some people soon began to realize the potential behind electronic games.

Sometimes called the father of home video games, Ralph Baer was an engineer at an American company named Sanders Associates. He led the Equipment Design Division of that company, and his main field of work was television design. He was constantly thinking about what he could do with television, and one day he came up with the concept of creating games. At that time he was not aware of the earlier games made by Higinbotham, Russell and others. Baer starting using some of Sanders' resources for experimenting with games, however his first creations were quite disappointing. His work was more about engineering than game design, and most of the company's executives felt he was just wasting time. His projects were under constant risk of being shut down, but after some time his games improved and in 1967

he came up with a ping-pong game where players had to control paddles to catch and bounce back a moving spot.

Because of economic and political reasons (Sanders Associates was a military contractor and could not afford putting much effort in toys), Baer's work was sold to the company Magnavox, and the project continued. In 1971 Baer created a prototype of a console which was named Odyssey and sold one year later. It had 12 games that could be selected by plugging cartridges into the console (the cartridges only triggered built-in games, instead of actually containing game code). Odyssey also included two controllers and overlays with background graphics, which had to be mounted on the TV screen according to the game being played. Also available for separate purchase was a rifle which could be used with some of the games.



Picture 7: Magnavox Odyssey components and *Table Tennis* (1972)

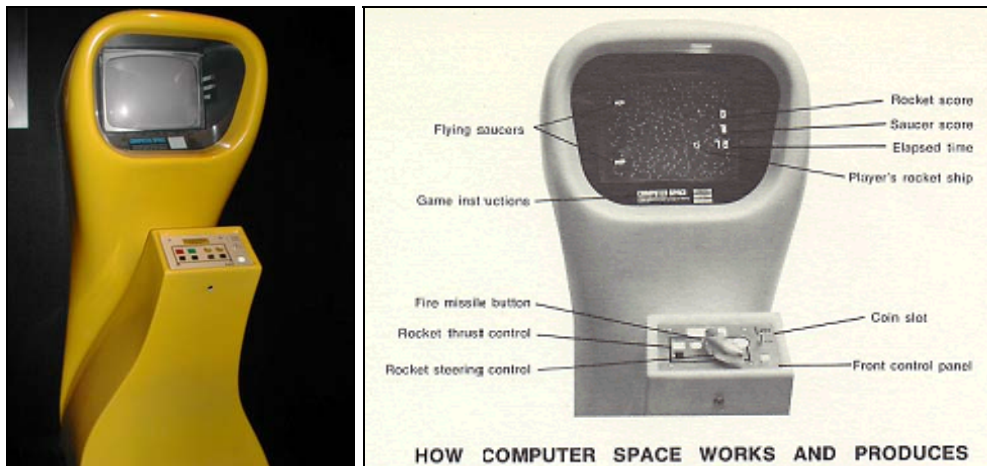
Magnavox sold 80,000 Odyssey units in 1972. Considering the high price (100\$) and bad marketing (salespeople did not know how to sell that kind of product, and advertising spots on television did not present it very well), it could probably have been much more, but in the years to follow the sales increased and several other versions of the console were made and even exported to several countries.

Odyssey was the first home video game system and made electronic games available to a broad public.

### **3.6 The First Arcade Games**

The first arcade game (i.e. a dedicated, coin-operated machine to be used in public places) was *Computer Space*, designed by Nolan Bushnell in 1971 and released by Nutting Associates. It was basically a remake of the earlier *Spacewar!* game by Steve Russell and involved a spaceship that must evade and fight enemy flying saucers. The hardware was specially designed and only capable of running that single game. 1,500 units were built and many of them

were installed in public places like bars throughout the United States, however, it failed to become a real success. *Computer Space*, like *Spacewar!*, was based on outer-space physics and required great skill and understanding of gravity to control the spacecraft and to fight the enemies. In order to be able to play the game, one had to read several pages of instructions and still, the game was much too difficult to play for the average user.



Picture 8: *Computer Space* with description (1971)

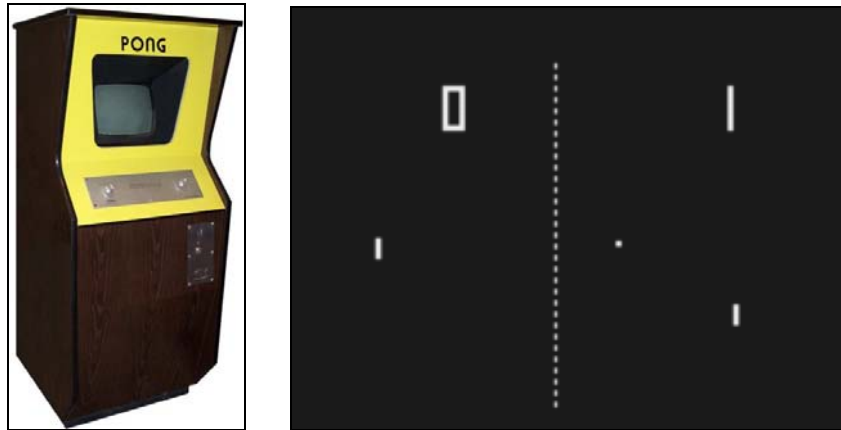
After the failure of *Computer Space*, its inventor Nolan Bushnell did not give up and decided to continue working on games. Together with a few of his colleagues he founded his own company in 1972, Atari (named after a position in the Japanese board game Go, similar to the concept of “check” in western Chess), which would become the fastest-growing company in United States history.



After some time of working on pinball games, Atari soon started a new attempt to create electronic arcade games. Nolan Bushnell's intention was to create a game even more complex than *Computer Space*. However, before beginning to work on plans for such a game, he hired a young engineer named Al Alcorn and decided to give him a simple project as an exercise. He told him to create a game of table tennis that should be as easy to play as possible. There was no intention to finish or even commercially use this game, but Alcorn proved to be highly motivated and innovative. After some months of work, he not only created a solid and fun game which was relatively cheap to produce, but also added his own ideas (like an accelerating ball, or the effect that the angle in which the ball bounced back was determined by the exact location of where it was hit by the paddle). The first working prototype surprised his

boss Nolan Bushnell, who named it *PONG* and decided to test its marketability by installing it at a bar which had been one of Atari's customers for some time and was already operating one of the *Computer Space* units.

This time however, the instructions accompanying *PONG* did not comprise several pages as it was the case with *Computer Space*, but only one sentence: "Avoid missing ball for high score". This kind of simplicity was exactly what many players were looking for.



Picture 9: Atari *PONG* (1972)

*PONG* became an instant success (legend has it that the prototype machine broke down on its first day because it got filled up with coins). Units were installed on more locations and every time became more popular than existing pinball machines and other coin-up games. In 1973, Atari started shipping machines to Europe and Japan (where the chief distributor Namco would later become an important gaming company of its own). Two years later, 19,000 units of *PONG* had been sold. The game that started as an exercise had become Atari's flagship product.

There has been some confusion and controversy about the relation of *Table Tennis* (the 1972 Odyssey home video game by Magnavox) and *PONG* (the arcade game by Atari released in the same year). Atari and other companies even made home versions of *PONG*, therefore directly competing with Magnavox. Questions came up about ownership and copyright infringement, and in the end, Atari paid a license fee to Magnavox and therefore indirectly admitted that the idea for *PONG* was inspired by *Table Tennis*. However, there was definitely a complementary effect which improved the popularity of both games.



Picture 10: Atari's home version of *PONG* (1975)

Following this success, many competing companies surfaced and wanted to take part in the new development by imitating *PONG*. Atari in turn tried to stay ahead and created more and more games such as *Pin Pong*, *Dr. Pong*, *Pong Doubles* and *QuadraPong*. Eventually, other game types than tennis variations were explored. Experiments began to create racing simulations and maze games. With dozens of companies now competing, the race for the arcade game market began.

Although Atari quickly solidified its hold on the market, other companies managed to create successful games as well. One such game was *Tank*, created by Kee Games in 1974 (this company was actually owned by Atari for strategic reasons and therefore no real competition). *Tank* was one of the first games produced in large numbers that went away from *PONG*-like games revolving around fast reflexes and simple game play. Instead, the player was put into a military setting and given control over a combat tank, trying to evade mines and kill enemies using artillery shells. Simply bouncing back balls with paddles had become boring for many players, and *Tank* provided just the new kind of action and excitement which many people were ready for. Furthermore, with many games on the market already, the quality of graphics began to play a role, and although *Tank* only had a black and white monitor, it did have graphical advantages because of its complicated playfield and detailed player sprites. *Tank* became a success, and again, spawned many variations.

Also in 1974, the first racing game made its way into the arcades: *Gran Trak 10* by Atari. The player's objective was to control a dot (the car) and complete laps as fast as possible. There were no opponents, obstacles or any other challenges besides the track and the clock. Although not unpopular, its main importance lay in the new concept of a racing game that opened up a flood of creative new ideas.



Picture 11: *Tank* by Kee Games (1974) and *Gran Trak 10* by Atari (1974)

## 4 The Golden Age of Arcade Games

The years around 1980 are commonly called the “Golden Age of Arcade Games”. Although by now arcade games had already existed for some time and were quite popular, a series of new innovations during these years brought video games to a new level and gave them a fixed place in mainstream popular culture. This was the time when computer games moved from a small branch of the entertainment industry to a huge mainstream phenomenon and suddenly could be found not only in a few bars, but in all kinds of public places like supermarkets or waiting rooms. Many of the games that are today considered a classic of the medium were released around 1980.

The following circumstances, among others, led to this boom:

- Increasing overall public acceptance of computer games
- More variation and creativity in game design; the willingness to try out new concepts instead of only cloning a few successful game ideas
- Higher processing power of hardware
- The development of color screens and vector displays for use in arcades

It should be noted that although technology made constant advances, it was still fairly basic, and games had to rely on innovative game play much more than on graphics. The key factors which made a game successful were ease of use and a fun idea. This is why many of these games had a long-lasting impact and can still be enjoyed today.

### 4.1 *Space Invaders*

One game that is sometimes said to have begun this Golden Age is *Space Invaders*, one of the most influential video games ever. Untypical for that time, it was developed in Japan (in 1978 by Taito) and only later introduced to the United States where it was produced and distributed by Midway-Bally.

At first, *Space Invaders* did not do too well in the arcades because its concept was very different from existing games: Players have to defend a space station from alien attacks by firing shots from a movable laser cannon; When the laser cannon is hit by a missile or when the advancing enemy ships reach the bottom (which happens faster and faster with every enemy

destroyed and with every level completed), the player loses a life. In addition, four bunker-like buildings provide some limited cover from enemy fire, thus adding to the overall defensive character of the game. This was unusual: In most other games, it was the player who always had the initiative and determined the course of the game, however in *Space Invaders*, there was a constant feeling of time pressure and fear that the enemy attack might at any time become too strong to defend against.



Picture 12: *Space Invaders* by Taito (1978)

After a few months however, the game became highly successful and more than 100,000 units were sold in Japan alone. It is said that it even caused a national coin shortage because so many people were playing it. One of the reasons for its success was its feeling of “completeness”. It had everything that a game needed for being enjoyed by many people for a long time: A unique game idea, simple but challenging game play, high scores, bonus opportunities and growing tension (almost despair) as the game progresses.

Another (smaller, but still important) reason for *Space Invaders*’ success was the way the enemy spaceships looked like: For the first time in game history, the characters of a game were designed in a way that gave an impression of “being alive” and that made them easily recognizable by players. Those spaceships ended up in having a big influence on popular culture and are still recognized by many people today. The importance of character design in games would later become much more apparent, most notably in games by Nintendo.



Picture 13: A reference to *Space Invaders* in a mosaic found in Vienna, Austria

*Space Invaders* sparked off the so-called “Shoot ‘em Up” game genre (see 11.3). It was also the first game to display a high score on the screen, thereby providing the motivation for playing again. This also means that there is no way to beat *Space Invaders*: The only thing one could aim for is surviving as long as possible and trying to achieve higher scores. This actually resulted in some criticism from concerned parents, who feared that such a “pessimistic” game – which can never be won no matter how hard one tries – would send a wrong signal to their children.

## 4.2 *Pac-Man*

*Space Invaders* achieved such high levels of popularity at the arcades that for some time it seemed to be impossible for any company to compete against it. However, very soon an even bigger hit emerged: *Pac-Man*. Just like *Space Invaders*, *Pac-Man* was easy to understand, fun and challenging, and it had nicely designed, recognizable characters. It was developed by Namco in Japan and released in 1980 by Midway. It became the best-selling arcade game of all time.

In contrast to other games of that time (which were mostly shooting games inspired by *Space Invaders*), *Pac-Man* was a completely new kind of non-violent game that was designed to appeal to both boys and girls. With its unique idea and overall good design of graphics and sound, it stood out of the masses and offered great motivation for being played again and again.

The game concept is well-known: The player’s objective is to maneuver “Pac-Man” (a yellow character shaped like a pizza with a missing wedge) through a maze filled with dots, evading

four enemy ghosts that try to catch him. Once all the dots are eaten, the level is completed and the next level begins. In addition, Pac-Man can eat four so-called “power pellets”, which for a limited time give him the ability to eat the ghosts that are chasing him, thus forcing them to return to their home before becoming active again. From time to time, bonus items such as cherries or oranges appear near the middle of the level which can be eaten in order to get extra score. A tunnel in the maze can help Pac-Man escape from one end of the level, returning to it at the opposite end.



Picture 14: *Pac-Man* by Namco (1980)

Like *Space Invaders*, *Pac-Man* also had an incredible influence on popular culture right from the start: Companies published strategy guides, there was a *Pac-Man* hit song and a cartoon show, and the character even appeared on the cover of *Time* magazine.

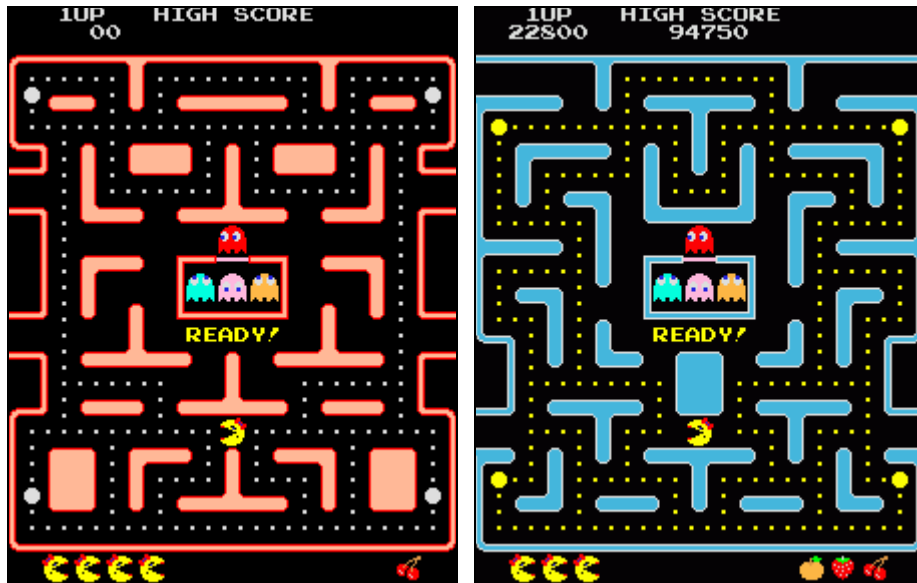
Due to its immense popularity, *Pac-Man* has been subject to intensive analysis. Some interesting facts about the game are:

- There is no random factor in the movement of the ghosts. This means that in any given game situation, they will always react in the same way. This predictability has led to the development of patterns for completing a level without any risk of running into a ghost. Using such patterns, top players can play the game virtually endlessly.
- There is a certain spot in the bottom part of the level, where Pac-Man can stay forever without ever being caught by the ghosts.

- In level 256, a bug causes the display to be messed up with text and symbols, making half of the level invisible. While some top players argue that with perfect timing and perfect knowledge of the level it is still possible to continue playing, the game is usually considered to end at that level. Of course it already takes a considerable amount of skill to even get that far.
- There is a certain “maximum score” that can be achieved (3,333,360 points). To get this score, it is necessary to eat all dots, all bonus items, all power pellets and each of the ghosts four times in all of the 255 levels.

*Pac-Man* has spawned many sequel games. The most popular of them is *Ms. Pac-Man*, which some consider to be even better than the original. The differences are:

- The main character (“Ms. Pac-Man”) is a female version of Pac-Man, having a bow, eye-liner, lipstick and a beauty spot. Also, one of the ghosts (“Sue”) is now considered to be female, although it is visually equivalent to its Pac-Man counterpart (“Clyde”).
- There are four different mazes.
- The movement patterns of the ghosts are now unpredictable, making it harder to develop strategies for beating a level.
- The bonus items (fruits) now slowly move around the level instead of waiting in the middle.

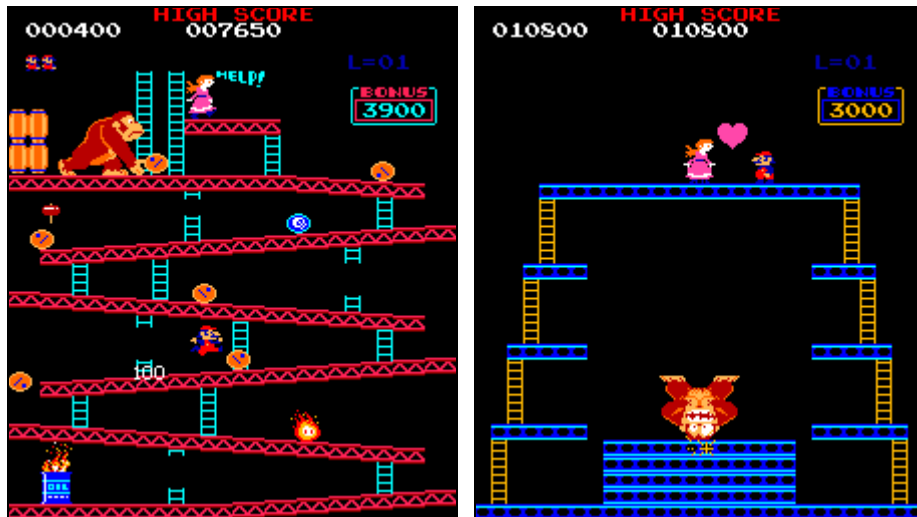


Picture 15: *Ms. Pac-Man* by Midway (1981)

Just as after the release of *Space Invaders* the arcades were filled with shooting games, after *Pac-Man* everyone in the industry produced maze (or “maze-chase”) games. Other popular examples of that genre include *Lady Bug*, *Thief* and *Mouse Trap*.

### 4.3 *Donkey Kong*

*Donkey Kong* was another major hit during the Golden Age of Arcade Games and is important for a number of reasons: First, it marked the rise of Nintendo, a company that would later become one of the most important players in the industry. Second, it was the first game of the Platform genre (see 11.2). Third, and perhaps most importantly, *Donkey Kong* continued to develop an element of video games that *Pac-Man* had begun: Character design. The main characters of this game (*Donkey Kong* and Jumpman, who would later be renamed Mario), created by world-famous designer Shigeru Miyamoto, are among the most recognizable in video game history, and today Nintendo games are still well-known for their excellent character design.



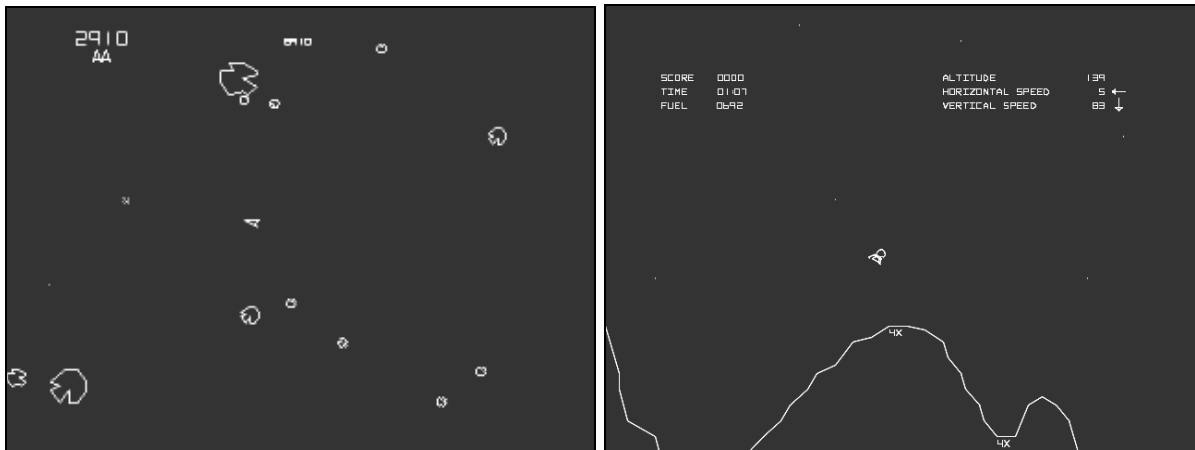
Picture 16: *Donkey Kong* (1981) by Nintendo

An interesting aspect of electronic game history that is clearly illustrated by *Donkey Kong* is the influence which television and other parts of popular culture sometimes have on games: It is said that part of Donkey Kong's success was derived from its resemblance with the well-known character King Kong from various films. Another example for such influence was *Space Invaders*, whose outer-space setting reminded many players of scenes they had seen in the popular Star Wars movies.

#### 4.4 Vector Graphics

Another invention of the "Golden Age" which heavily influenced later games was vector graphics. This technology was an alternative to the prevalent raster-scan monitors and allowed for completely new visual impressions. Games using vector graphics could draw sharp edges and smoothly moving sprites with high contrast, which – although that way of drawing has downsides of its own – introduced a new type of gaming experience.

Famous examples which made use of vector graphics are *Space Wars* (inspired by the earlier *Spacewar!*) in 1978, *Asteroids* in 1979, *Lunar Lander* in 1980 and *Tempest* in 1980.



Picture 17: *Asteroids* and *Lunar Lander* by Atari, 1979

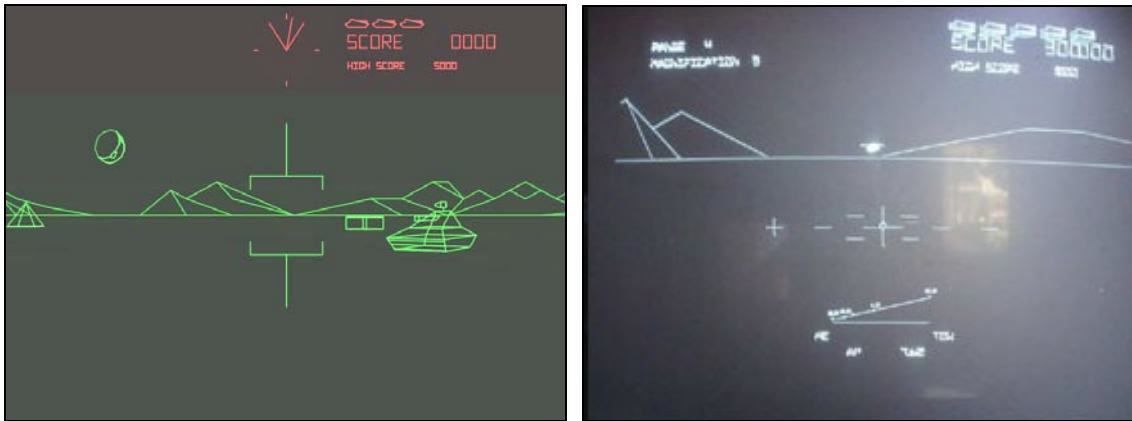
As was previously the case with raster-scan monitors, early vector graphic displays were also limited to black and white color. Sometimes manufacturers used colored plastic overlays on their games to create the illusion of color in certain regions of the screen.

## 4.5 *Battle Zone*

After the creation of 2D vector graphics, the next step was moving to 3D. This step was taken as early as 1980 by Atari with the game *Battle Zone*. Being the first 3D game ever released, *Battle Zone* was also one of the first games to emphasize the importance of technology: The very first games in history were so limited in their technical capabilities that they had to rely on a good idea and fun game play (which is actually a good thing), however, *Battle Zone*'s main appeal lay not in its game play but in its first-person view of an exciting three-dimensional world. In this game, the player has to destroy slow tanks, fast tanks and flying UFOs by firing projectiles at them. In addition, it is necessary to avoid enemy fire by either moving around or hiding behind various obstacles.

The game also featured a radar view of the surrounding area, a feature which would later become indispensable in simulation games.

*Battle Zone* is also known for its relation to the military: After its success in the arcades, Atari was approached by officials of the United States military, who wanted a modified version to be used for training tank gunners. This modified version was much more realistic and included various kinds of weapons, enemy as well as friendly tanks, and the need for ballistic considerations of weapon trajectories.



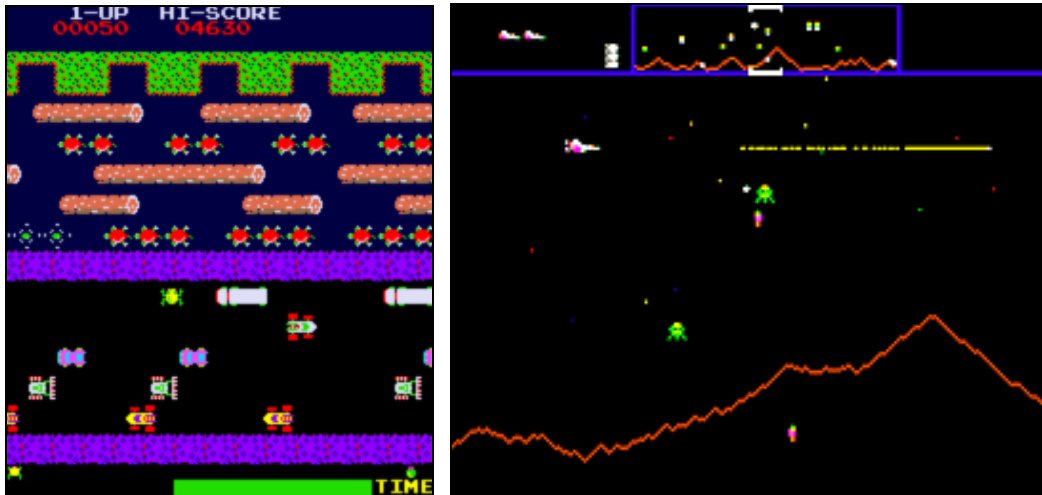
Picture 18: *Battle Zone* by Atari in its arcade (left) and military (right) version (1980)

## 4.6 Other arcade games

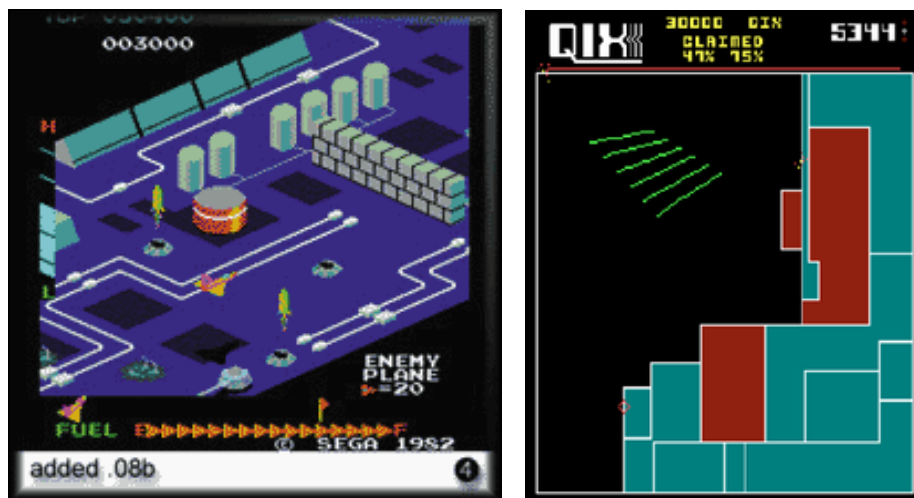
After the success of *Space Invaders* and *Pac Man*, most games in the arcades were either shooters, maze games or games using vector graphics. Some outstanding classic arcade games which have achieved considerable popularity include the following:

- *Frogger* (1981): A game in which the player has to guide a frog over a busy street and a dangerous river to its home.
- *Defender* (1980): A horizontal-scrolling “Shoot ‘em Up” game, credited as being the first game in history to include some kind of “virtual world” (in this case, the landscape of an alien planet).
- *Zaxxon* (1982): A “Shoot ‘em Up” game with a unique isometric perspective.
- *Qix* (1981): A puzzle game in which the player has to trap a strange alien entity by reducing screen area around it.
- *Centipede* (1980): The first game designed by a woman (Dona Bailey), similar to *Space Invaders*.
- *Tron* (1982): A game based on the Walt Disney movie *Tron*.
- *Pole Position* (1982): One of the first racing games with for its time incredibly realistic 3D graphics. *Pole Position* requires fast reaction and precise movements and is considered to be a pioneer of its genre. Its innovative “rear camera view” is still found in today’s much more advanced racing games.

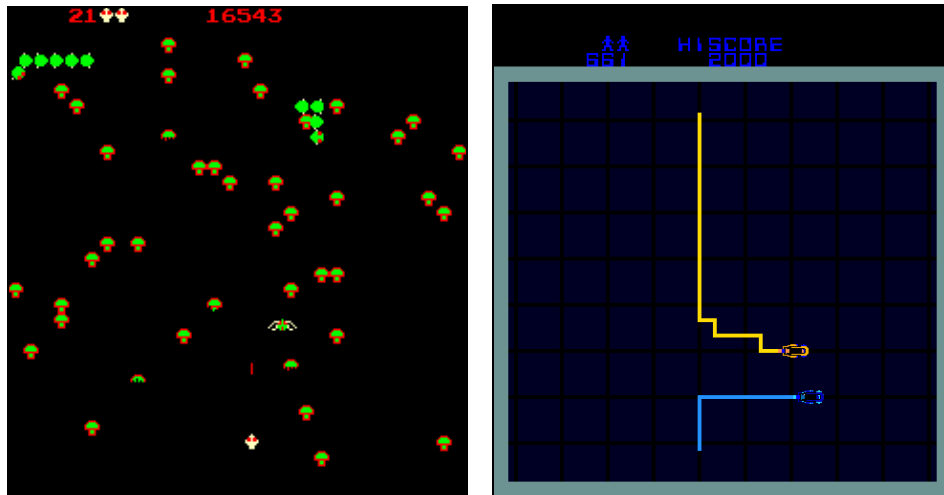
- *Burgertime* (1982): An interesting game where the player has to arrange buns, meat, lettuce tomatoes and cheese in the right way in order to create burgers.
- *Tapper* (1983): A game where a bartender has to quickly serve customers with beer. One of the first games to make use of branding: A Budweiser logo is seen in the background.



Picture 19: *Frogger* by Konami (1981) and *Defender* by Williams Electronics (1980)



Picture 20: *Zaxxon* by Sega (1982) and *Qix* by Taito (1981)



Picture 21: *Centipede* by Atari (1980) and *Tron* by Bally Midway (1982)



Picture 22: *Pole Position* (1982) and *Arkanoid* (1986)

## 5 Early Home Consoles

Around 1980, arcade games were a huge success. At the same time, first generation home systems such as the Magnavox Odyssey were not as popular. Soon however, companies began working on second generation consoles and devised a simple strategy: Take the most popular arcade games and create home versions of them. This worked: People suddenly were able to play their favorite games like *Space Invaders* or *Pac-Man* at home.

### 5.1 Atari VCS / 2600

Atari was clearly the leading company in the arcade business. In addition, they were also highly successful with an attempt to create a home console called the Video Computer System (VCS), later renamed to Atari 2600. This device was released as early as 1977 and remained popular for over one decade.

In contrast to first generation home consoles like the Magnavox Odyssey, the Atari 2600 had an 8-bit digital CPU instead of simple analog electronics and stored games on cartridges, which resulted in an extensible system: People could now get new games simply by buying new cartridges. (In fact, the Odyssey also had cartridges, but no actual information was stored on them; they were only used to trigger games that already existed in the console).

One of the factors that made the Atari 2600 very successful was Atari's policy of supporting third-party game development: Several companies (for instance, Activision) emerged that specialized in developing games for the Atari console, which resulted in a large variety of games that could not be matched by competing home consoles.

About 26 million units were sold world-wide and 500 games developed.

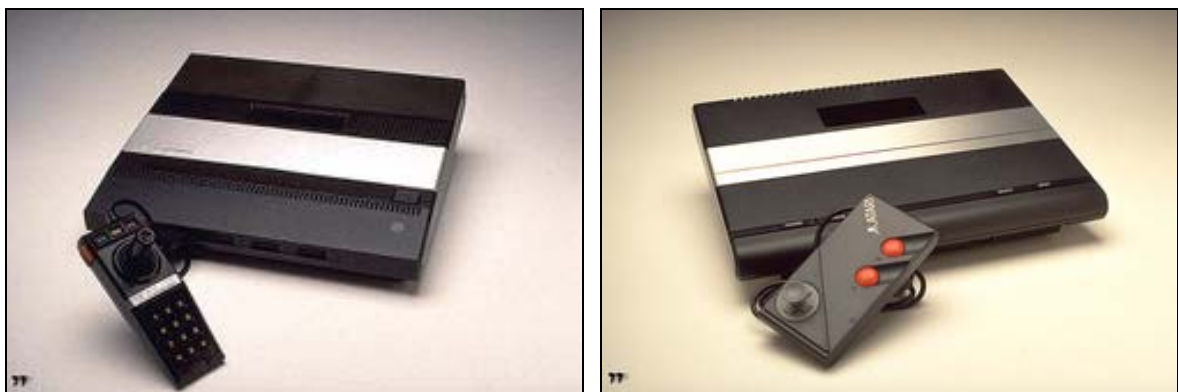
Technical specifications of the Atari 2600:

- 8-bit CPU at 1.19 MHz
- 128 Bytes RAM
- 4096 Bytes ROM
- 160x196 screen resolution with 128 colors
- Two controller ports for various controllers like joysticks or paddles



Picture 23: Atari 2600 and its version of *Space Invaders* (1977)

After the success of its Atari 2600, the company later released upgraded versions called Atari 5200 (in 1982) and Atari 7800 (in 1986) in order to keep up with its competition. However, both systems suffered from several problems (incompatibility with earlier systems, high price, and lack of games) and were not nearly as successful as the original Atari 2600.



Picture 24: Atari 5200 (left) and Atari 7800 (right)

## 5.2 Magnavox Odyssey 2

In 1972, Magnavox had pioneered home video games with its Odyssey console and the *Table Tennis* game. Now it challenged Atari's leading role in the industry by releasing Odyssey 2 which – like the Atari 2600 – had a microprocessor and read games from cartridges. In the end it could not live up to its competition, mainly because of its technical inferiority and lack of games. However, the Odyssey 2 was rather successful on the European market, where it became known as the “Philips Videopac G7000”.

About 2 million units were sold world-wide and 50 games developed.

Technical specifications of the Magnavox Odyssey 2:

- 8-bit CPU at 1.79 MHz
- 64 Bytes RAM
- 1024 Bytes ROM
- 160x200 screen resolution with 16 colors
- A keyboard on the console and two external 8-way, one-button, digital joysticks



Picture 25: Magnavox Odyssey 2 and one of its games, *Smithereens* (1982)

### 5.3 **Mattel Intellivision**

Another home console that became quite popular was the Intellivision, released by Mattel (a toy company known for creating the Barbie doll) in 1980. It was the first 16-bit console and became a worthy competitor for the dominating Atari 2600. The Intellivision hardware was more powerful and the games tended to have more detailed graphics.

About 6 million units were sold and 125 games developed.

Technical specifications of the Intellivision:

- 16-bit CPU at 0.89 MHz
- 1352 Bytes RAM
- 7168 Bytes ROM
- 160x196 screen resolution with 16 colors

- Two key pads with 12 keys (10 digits, Clear, Enter) and a “directional disk” which can be pushed to indicate a direction in which to move or shoot; This directional disc functioned like a joystick and was able to distinguish 16 different directions, which was unique at that time and made the Intellivision especially useful for sports simulations.



Picture 26: Mattel Intellivision and one of its games: *Soccer* (1979)

## 5.4 ColecoVision

Perhaps the most powerful home console of the second generation was the ColecoVision. It was technically superior to all other consoles at this time and shipped with the game Donkey Kong that was already very popular in its arcade version. The ColecoVision’s processing power made games look just like they looked in the arcades, while the Atari 2600 and others were much simpler in terms of graphics and sound. The two most interesting features of this home console were that it was able to play games from other systems (most notably, the popular Atari 2600), and that its hardware could be upgraded.

Similar to the Intellivision, ColecoVision sold about 6 million units and about 100 games were developed.

Technical specifications of the ColecoVision:

- 8-bit CPU at 3.58 MHz
- 8192 Bytes RAM, 16384 Bytes Video RAM
- 8192 Bytes ROM
- 256x192 screen resolution with 16 colors
- Two key pads with 12 keys, a flat joystick and 2 side buttons



Picture 27: ColecoVision and its version of *Donkey Kong* (1982)

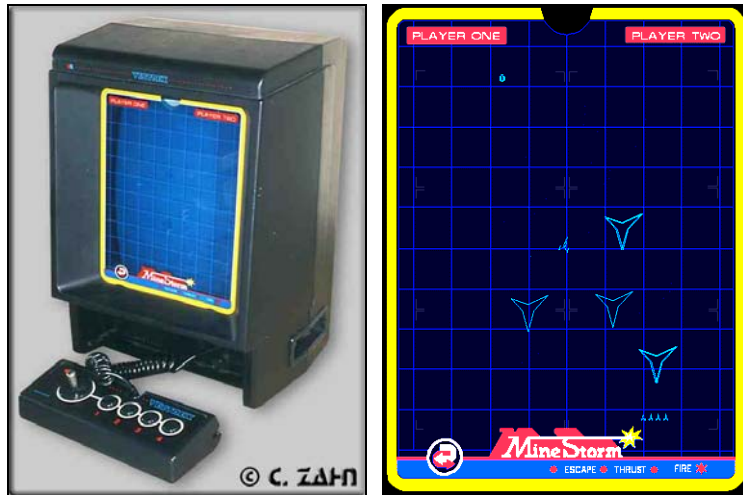
## 5.5 Vectrex

The Vectrex was a vector-based console. Most notably, it had its own screen, therefore eliminating the need for a television set. It used plastic overlays to simulate color on the screen.

This device was mainly aimed at gamers who were already familiar with vector graphic technology from arcade games, such as *Asteroids* or *Lunar Lander*. For most people however, other consoles using raster-scan graphics were more appealing.

Technical specifications of the Vectrex:

- 8-bit CPU at 1.6 MHz
- 1024 Bytes RAM
- 8192 Bytes ROM
- Black&White CRT screen
- Two controllers with an analog joystick and four buttons



Picture 28: Vectrex and its most popular game: *Mine Storm* (1982)

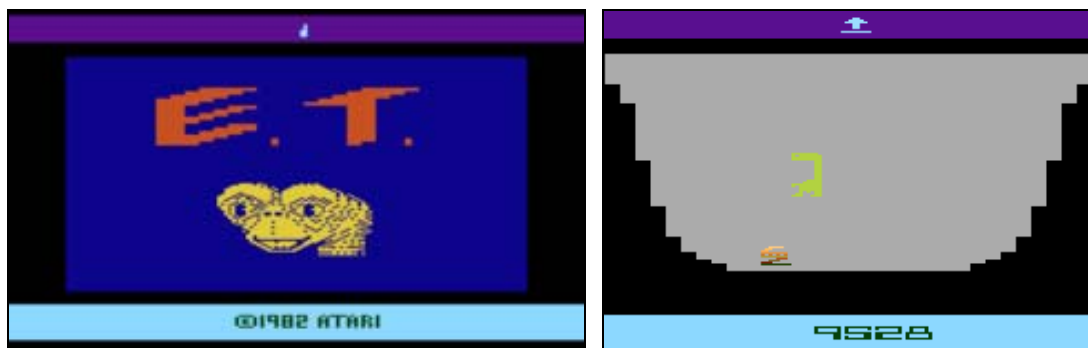
What all these early home consoles had in common was that their success was mainly derived from the popularity of arcade games. Most games available for the consoles were simply ports of their arcade counterparts. There were not yet serious attempts to design games specifically for the home market.

## 6 Decline of Arcade Games and Home Consoles

In 1983, both arcade games and home video consoles lost popularity. First, it hit the arcades: Many players started playing their favorite games at home instead of going to the arcades, which was cheaper and also more comfortable, since arcades by now had earned a reputation of being unclean, possibly even dangerous places. In addition, most available games were only clones of *Space Invaders*, *Pac-Man* and a few other great hits. No really new ideas were explored, which resulted in a loss of interest.

The arcade industry did not “crash” or cease to exist, it just stopped growing and experienced a slow decline. Arcade games never completely went out of business and some continue to be popular to this day. In the late 1980s and the 1990s, new technologies and game genres were explored and several individual arcade games became highly successful. But they would never again achieve popularity as high as in their Golden Age.

The lack of new ideas in arcade games also immediately affected home video consoles, since they were mostly designed to be exact copies of arcade games. Also, games that were specifically designed for home consoles usually failed miserably. The most prominent example for such a failure was *E.T.* for the Atari 2600 in 1982, which had high expectations due to the success of the movie it was based on, but suffered from an uninteresting background story (E.T. had to run around on a few screens trying to find parts for assembling a telephone), boring game play (most of the game involved falling in pits and trying to get out of them) and bad graphics. The *E.T.* game is sometimes said to be the worst game ever created and is an example for a failure caused by the strong preference of economic considerations over quality.



Picture 29: The worst game ever? *E.T.* by Atari (1982)

However, the biggest reason for the downfall of home consoles was not the lack of quality and diversity, but the advent of an alternative: Home computers. People felt that instead of buying a game console, they would be better off with a home computer that offered more “useful” possibilities (like word processing and programming) at about the same price. Also, many parents decided that a home computer would help their children with their education instead of being a waste of time and money.

## 7 Early Home Computers

During the Golden Age of Arcade Games, home computers had already been on the market for a while, but were more regarded as a business tool than as a useful device for the general public. They tended to be too expensive for the average person to afford.

During and after the decline of arcade games and home game consoles however, public interest shifted more and more towards home computers (or “personal computers”), which became cheaper and cheaper. They differed from the familiar game consoles in several ways: Computers had general-purpose processors, an operating system, and they were easily extensible with various input devices, storage hardware, printers and other components. These features provided a high level of flexibility and allowed for a wide range of applications like word processing and programming. For a short time, it looked like gaming would come to an almost complete end: The public fascination for home computing and its applications seemed to have replaced the interest for video games. What no one could foresee was how soon the potential of personal computers for games would be discovered.

In general, computers offered much higher flexibility and more possibilities for programmers than consoles, which resulted in a wide variety of new game ideas and genres. In addition, programming languages and other software made it possible for interested people to experiment with creating their own games.

Of course, personal computers also had another “advantage” over the earlier game consoles: Games could now be stored and copied on floppy disks and easily distributed to and acquired from friends: Software piracy began. This definitely helped increase the popularity of both computers and their games.

### 7.1 *Apple II*

The Apple II was one of the first personal computers. Highly successful, it was introduced as early as 1977 and produced until 1993 in several variations. Its first versions were equipped with an 8-bit microprocessor running at 1 MHz, 4 KB RAM, a display capable of different video modes (including color), sound output and data storage on cassettes or 5 ¼ floppy disks. Later



versions like the Apple IIgs had better CPUs, more memory, better screens and various other extensions. Available Software included a word processor, the BASIC programming language

and a popular spreadsheet application (VisiCalc). The Apple II was well documented and useable with only moderate amount of learning. It effectively set off the whole personal computing industry and many aspects of its design influenced the development of other computers such as the Commodore 64 and the IBM PC.

As an interesting fact, two prominent people associated with the Apple company had worked for Atari in the past, namely Steve Wozniak (developer of several Apple II hardware components) and Steve Jobs (co-founder and CEO). Probably because of their background in the gaming industry, the Apple II had support for gaming as well (color, sound and a gameport for support of external game devices like joysticks).

The Apple II is especially well-known for its role-playing games, among them the first five games of the popular *Ultima* series. People began to realize that personal computers were just as suitable for games as they were for “serious” applications.



Picture 30: Apple II and *Ultima V* (1988)

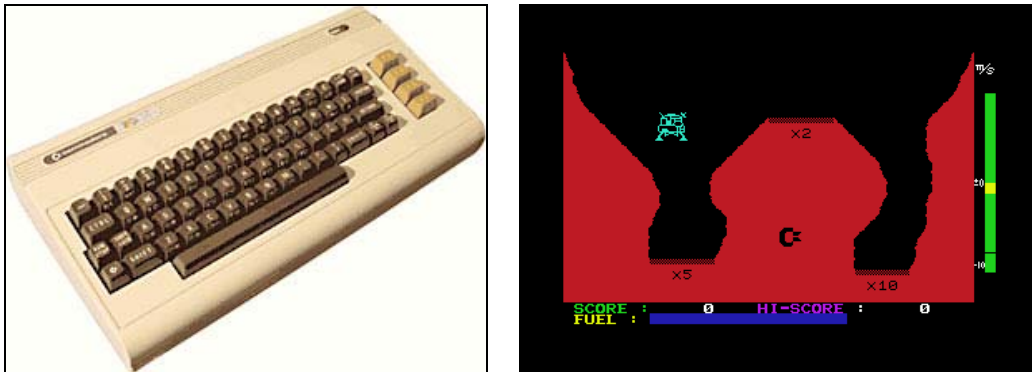
Being the only serious computer on the market for some time, about 5 million units of the Apple II were sold and a respectable number of about 1000 games were made. However, the main downside of the Apple II at the time of its release as well as in later years was its price. Initially released for US\$ 1300, it was too expensive for teenagers and casual home users and primarily remained a business machine.

## 7.2 Commodore

Another big player in the emerging computer market was Commodore International. In contrast to Apple, Commodore



early envisioned computers “for the masses”, even before the arrival of the IBM PC. Their first successful home computer – the Commodore VIC 20 – was released in 1981 at a price of US\$ 300, which was considerably lower than that of the competition. Although technically only moderate (8-bit 1 MHz CPU, 5 KB RAM, 16 color graphics), it turned out to be a well-balanced truly “personal” computer that for the first time attracted the general public: In 1982 it was the best-selling computer of the year, and in 1983 it was the first ever to pass the 1 million unit mark.



Picture 31: Commodore VIC-20 and one of its games, *Jupiter Lander* (1982)

Having sensed the enormous potential of affordable personal computers, Commodore International soon released their next product, the Commodore 64 (sometimes abbreviated as “C=64” or simply “C64”) in 1982, which was superficially similar to the VIC-20, but more powerful than its predecessor and designed to be a direct alternative to the expensive Apple II. It became the best selling single computer model of all time (more than 20 million units) and a legend among gamers. There were several reasons for its success:

- An innovative distribution model. While other companies relied on a few authorized dealers to sell their devices, Commodore computers were available practically everywhere.
- Like the VIC-20 it came at an affordable price (US\$ 595).
- At the same time, it was powerful and versatile enough to support a wide variety of applications and games. In particular, the C64 had specialized graphics and sound hardware that allowed completely new levels of creativity. Its graphic chip offered functionality such as sprites and hardware scrolling, while its sound chip (the famous SID) was specifically designed for music and supported three channels as well as several waveforms,

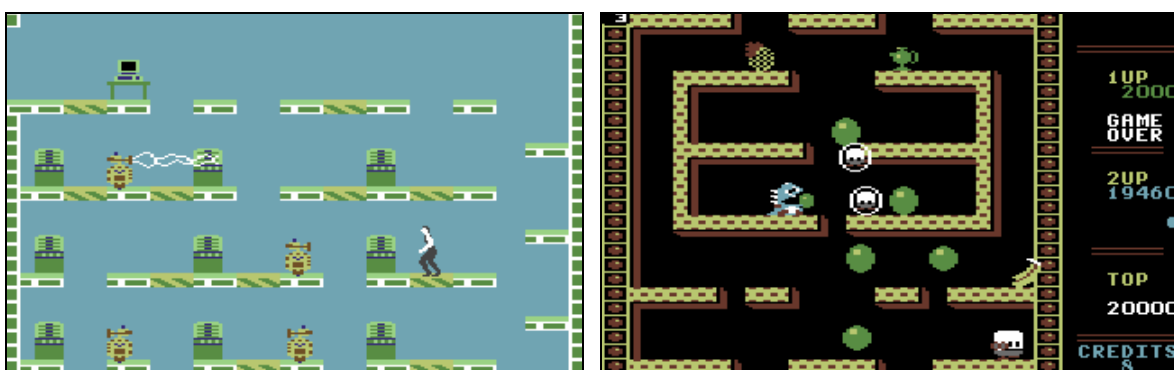
modulation and filter capabilities. Considering that other computers used sound only for very basic signaling, this was a real innovation.

- The C64 had a good programming interface that attracted both programmers of other systems and new learners.
- A great range of peripherals was developed.

The games produced for the C64 were numerous and known for their quality, and included ports from arcade games and other systems as well a wide array of newly made games. Many of them became classics or even sparked off whole new genres, and today most people associate the C64 primarily with gaming. Whole companies like Accolade, Microprose and Electronic Arts were established or changed their focus to developing games for the C64.



Picture 32: Commodore 64 and *Winter Games* by Epyx (1986)



Picture 33: *Impossible Mission* by Epyx (1984) and *Bubble Bobble* by Firebird (1987)

Due to its revolutionary features in graphics and sound, the C64 not only attracted programmers, but also musicians and other artists, and is credited with initiating the demo scene: The art of producing non-interactive audio-visual presentations aimed at utilizing the capabilities

of a computer to the maximum. To this day, artistic achievements of the demo scene and the game industry mutually influence each other.



Picture 34: *Game Music IV*, a non-interactive demo program for the C64 (1985)

### 7.3 Atari 800

Atari had also realized the potential in the emerging market of home computers, and instead of developing new variants of their successful game consoles, the company presented the home computer Atari 800 in 1979. It had an 8-bit 1.8 MHz CPU, 8 KB RAM (upgradeable to 48 KB) and supported color displays, external floppy drives, cassette recorders and printers. Built-in ROM software included a simple disc operating system and an interpreter for the BASIC programming language. Because of Atari's high experience in games, this new computer also had several features that made it suitable for this kind of applications: It supported up to four joysticks at the same time and had powerful hardware (co-processors) for graphics and animations.

Due to this strong support for games, the Atari 800 quickly became popular. In some ways it can really be described as a hybrid device between a home computer and a video game console, therefore, it was better suited for games than its competitors like the Apple II. Games like the 3D combat space simulation *Star Raiders* (an important predecessor to *Wing Commander*, *X-Wing* and other games of this genre) convinced some game designers to prefer the Atari computer over Apple. However, this specialization in games also limited the flexibility of the Atari 800, and as a result it was inferior in upcoming areas like word processing or programming. Furthermore, by now many customers and software developers had come to associate the Atari brand with toys rather than with serious computing devices. In the end, al-

though accepted by gamers for some time, the Atari 800 could not keep its popularity for long and failed to establish itself as a serious home computer.



Picture 35: Atari 800 computer and one of its games, *Star Raiders* (1979)

Several more or less successful variants were released in later years, like the Atari 800 XL, but Atari's popularity would never again fully recover after the 1983 decline of arcade games.

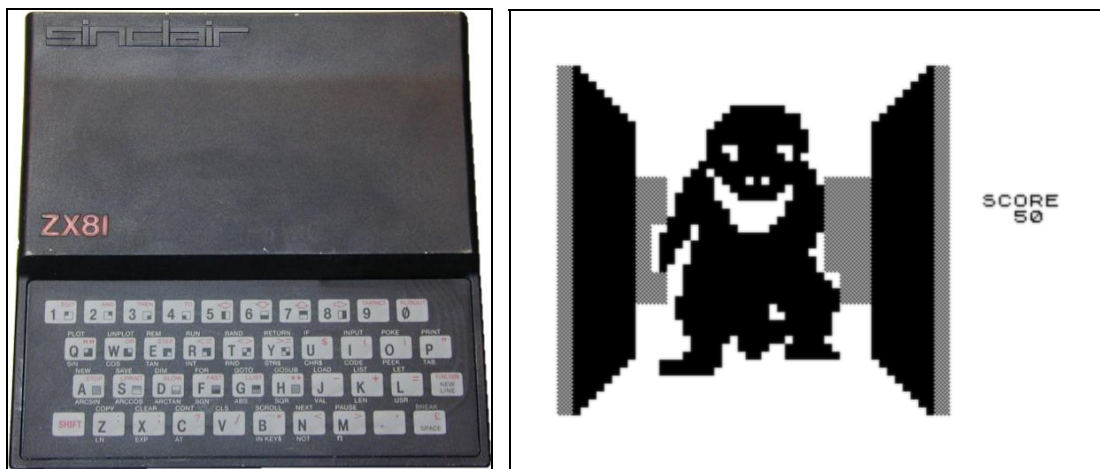
#### **7.4 ZX 80, ZX 81 and ZX Spectrum**

Most companies competing for the home computer market were American; however, one British company also achieved considerable success: Sinclair Research. Their first computer, the Sinclair ZX 80 (first sold in 1980) immediately raised a lot of interest. It was smaller and technically inferior to machines of other companies (no colors, no sound and only 1KB RAM), but it was the first computer to be sold for less than 100 British pounds (£99.95 to be exact), which was considerably less than the price of an Apple II, for example. It used a television set for display and cheap audio cassettes for storage and was therefore affordable for almost everyone. Still, it had all the features a home computer needed at that time: word processing, a programming language and even some games. Its successor, the Sinclair ZX 81, which was already released in the same year, had slightly better hardware and was even cheaper than the ZX80. In addition, it had a distinguished design which also made it visually appealing (an asset which would later also be important for the success of the Apple Macintosh).

As an interesting detail, the ZX 81 computer was unique in that it did not internally use the ASCII standard for character representation but had its own character set; an indication for an attempt to counter American dominance on the computer market. Indeed, the ZX 81 proved to

be highly successful in Europe (about 1.5 million units were sold). However a later attempt to introduce it to the American market (under the name Timex Sinclair TMS-1000) was rather unsuccessful.

The most popular game on the ZX81 was *3D Monster Maze*, the first three-dimensional game involving a dungeon which the player has to explore. It became famous because it used only very simple technical means (black and white low-resolution graphics, no sound) and an equally simple idea (a maze containing only a single enemy – a Tyrannosaurus Rex), yet it was able to raise a high level of suspense.



Picture 36: Sinclair ZX81 and the game *3D Monster Maze* (1981) featuring a frightening Tyrannosaurus Rex

One year later in 1982 – mainly to compete with the new Commodore 64 – Sinclair released another home computer: the Sinclair ZX Spectrum. As before, the company favored a low price over technical complexity. The Spectrum still used the original ZX 80 CPU and audio cassettes as its storage device, however, even the first version of this computer now had color output (hence the name “Spectrum”). Various extensions and later variants (like the Spectrum+ and the Spectrum 128) added even more other capabilities like a sound chip, joystick ports and more RAM. Just like its predecessor ZX 81, the Spectrum became a big success in the United Kingdom, but mostly failed in other countries.

The Sinclair ZX Spectrum offered a wide range of software. It had various programming languages (most other computers had only BASIC), word processors, spreadsheets, databases and painting applications. As far as games are concerned, the computer is known for its variety: In contrast to other home computers, it had no internal support for sprites, scrolling and other operations commonly needed in games. This apparent disadvantage meant great flexibil-

ity and forced programmers to write all code on their own, which actually resulted in very creative games not bound to a common “Look and Feel” as it was experienced on other computers and game consoles. This also meant that most games on the Spectrum were exclusively developed for this computer and not available on others.

Popular games include *3D Deathchase*, an early example for a first person shooter, *Rebelstar*, a turn-based strategy game, and *R-Type*, a popular horizontal “Shoot ‘em Up” arcade game ported to the ZX Spectrum and other platforms. The ZX Spectrum also saw the first real-time strategy game in history, *Stonkers*.



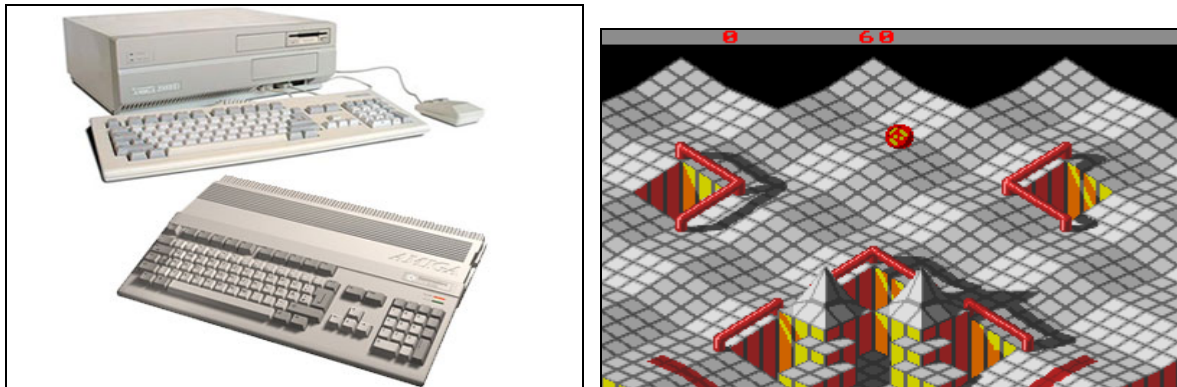
Picture 37: Sinclair ZX Spectrum and the game *Rebelstar* (1986)

## 7.5 Commodore Amiga

The Amiga was Commodore’s next model after its successful C64, and – although it was in fact designed to be a general-purpose computer – it was soon used almost exclusively as a gaming machine. As it was the case with the C64, other uses included multimedia applications such as sound composition or non-interactive demos. The Amiga was technically advanced, e.g. it had a 16-bit CPU and specialized subsystems for excellent audio and video capabilities. First released in 1985, it was in many aspects superior to any other platform of that time, earning it a well-deserved place in electronic game history. Until the early 1990s, when the IBM PC became the strongest gaming platform, games on the Amiga generally looked and sounded better than on other computers or consoles.

The Amiga is also notable for popularizing software emulation: Using various tools and add-ons, it could execute programs from many other platforms, including the IBM PC, the C64 and the Apple II.

After the original model, Commodore released several upgraded variants of its Amiga computer, the most popular being the Amiga 500 and the Amiga 2000, both in 1987.



Picture 38: Left picture: Amiga 2000 (top) and Amiga 500 (bottom), Right picture: An Amiga version of the arcade games *Marble Madness* (1986)



Picture 39: The popular Amiga games *Xenon 2* (1989) and *Speed Ball 2* (1988)

## 8 The Return of Consoles

### 8.1 *Nintendo Entertainment System (NES)*

*“Now you are playing with power!” – Nintendo’s advertising slogan*



In 1983 it seemed that the rise of home computers would completely eliminate consumer interest in both arcades and game consoles. Most established companies (e.g. Atari) in the USA shifted to the emerging home computer market instead of taking the risk to further develop their consoles.

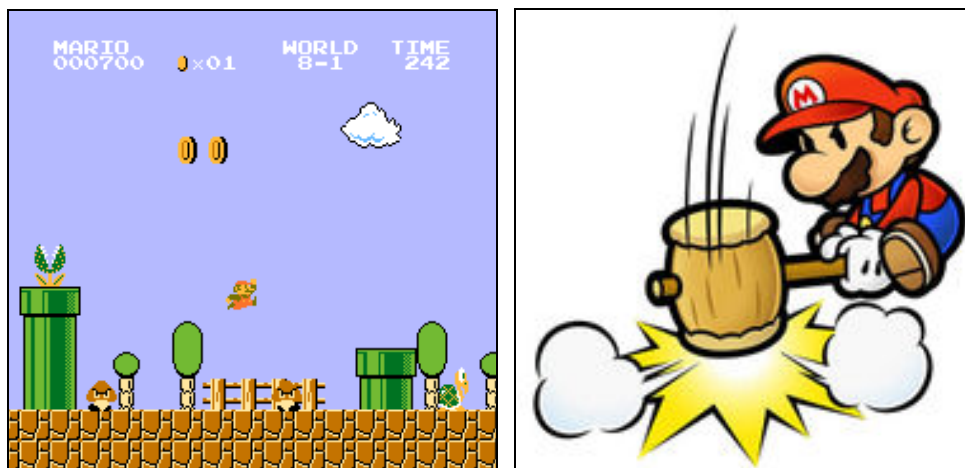
However, one Japanese company – Nintendo, which had already had considerable success with their arcade game *Donkey Kong* – had just developed plans to create a game console of their own and decided to hold on to these plans even in view of the current market situation. First introduced in Japan in 1983 (which was not as badly affected from the game crisis as the USA), their 8-bit console Famicom (“Family Computer”) was highly innovative, with its controller being its strongest point. Earlier console controllers like joysticks or keypads were either difficult to handle or fragile, or limited for use for specific types of games. In contrast, Nintendo’s controller – a plus-shaped gamepad with only two simple buttons – was more intuitive and robust. After some initial problems (including a recall of the first units shipped due to hardware problems), the Famicom became a huge success: More than 500,000 units were shipped within only two months after introduction. Because of this success, Nintendo even took the risky step of releasing the console in the American market, where everybody seemed to have lost the interest in video games. It was renamed Nintendo Entertainment System (or “NES”), test-marketed in New York City at Christmas 1985, and released nation-wide one year later.



Picture 40: The Famicom (Japan, 1983) and its American/European counterpart NES (1985)

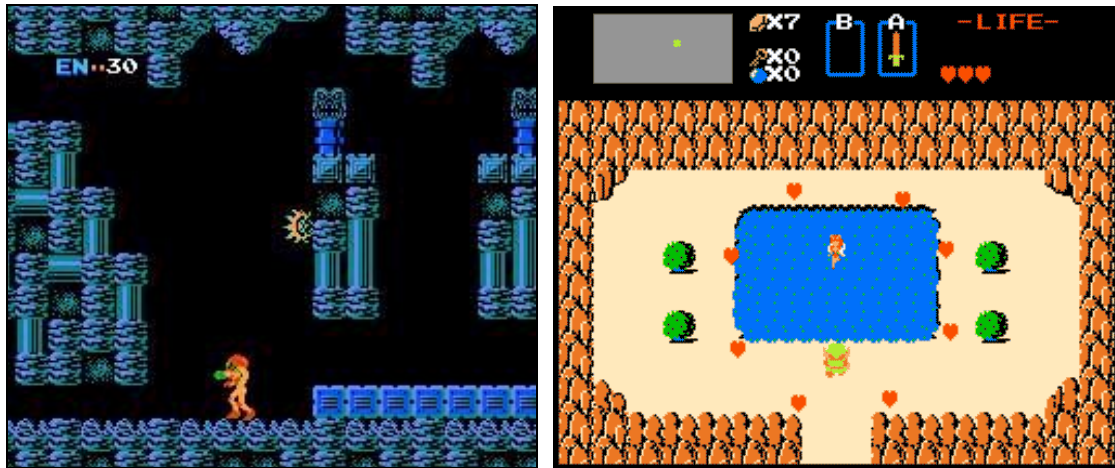
At first only moderately successful, it soon became a big sensation, partially because of its overall good design and a well-devised marketing strategy, and partially because of a game that shipped with the console: *Super Mario Bros.*, designed by Shigeru Miyamoto, who had also created *Donkey Kong*. This game was revolutionary in several ways and defined the difference between “old” games on Atari and similar systems and the “new” NES. It set standards for the Platform game genre (see 11.2), and the NES’ gamepad controller and its graphics hardware proved to be especially suitable for such games.

*Super Mario Bros.* included a colorful, vivid, scrolling world which the player could explore by running and jumping around on platforms. It had fast action, a sense of humor and beautiful landscapes. In addition, it had outstanding character design: Mario – the game’s protagonist – is one of the most recognizable fictional characters created and later appeared in over 100 games.



Picture 41: *Super Mario Bros.* (1985) and a later version of the Mario character.

Other popular NES games included *Metroid* (1986), *The Legend of Zelda* (1986), *Castlevania* (1986) and *Mega Man* (1987), all of which later developed into entire series of games.



Picture 42: *Metroid* by Intelligent Systems (1986) and *The Legend of Zelda* by Nintendo (1986)

With no other company prepared for a revived game console market, Nintendo – a company that had been established almost 100 years earlier in 1889 (producing handmade cards for a Japanese card game at that time) – managed to achieve complete control within two years. In total, about 60 million units of the Famicom/NES were sold.

Nintendo is also known for introducing a new policy towards third-party developers: Companies were actively encouraged to develop games for Nintendo consoles, however bound to strict terms. This on one hand led to an increased number of available titles, while at the same time making it possible for Nintendo to ensure the quality of the games and to otherwise control the market. Nintendo tested all games before giving approval to release them, decided how many units of each game would be sold and even censored material believed to be unsuitable for teenagers, which resulted in the “family toy” image some players still associate with Nintendo today. This strategy of exerting a strict monopoly over game production, albeit leading to much criticism, proved successful for several years until the arrival of serious competition for the NES.

## 8.2 Sega Master System

*“Now there are no limits!” – Sega’s advertising slogan*

One such competition was Sega (“Service Games”), a company which – similar to Nintendo – had been founded



much earlier (in Sega's case, in 1940 under the name "Standard Games" with the goal of producing coin-operated amusement devices on American military bases). During the 1980s, like Nintendo, Sega had already achieved considerable success with arcade games and was known for *Frogger* (1981) and *Zaxxon* (1982).

Sega's first home console – the Sega Master system (released in 1985) – was an attempt to directly compete with Nintendo's dominating NES. It gained some success in a few countries like Brazil and the United Kingdom but ultimately failed to come close to the NES' popularity. Its biggest problem was a lack of available games, and Sega would only later achieve real prominence with its Mega Drive.



Picture 43: Sega Master System (1985) and *Wonder Boy* (1986)

About 13 million units of the Sega Master System were sold.

### 8.3 *Sega Mega Drive*

This was Sega's second attempt to challenge Nintendo's dominance. The Mega Drive (released in 1988) was a futuristic and technically superior 16-bit console which provided programmers with advanced processing power. It clearly had an edge over the Nintendo console in terms of game complexity and graphics.

Similar to the NES, Mega Drive games were also mostly platform games and characterized by colorful, action-paced worlds filled with monsters and items. However, the console's technology was well-prepared for other genres as well. The game that shipped with it was *Altered Beast* (1988); other popular titles included *Golden Axe* (1989), *Sonic the Hedgehog* (1991) and *Phantasy Star IV* (1993), an early console Role Playing Game.



Picture 44: Sega Mega Drive (1988) and *Altered Beast* (1988)



Picture 45: *Golden Axe* (1989) and *Phantasy Star IV* (1993) on the Sega Mega Drive

With the introduction of the Mega Drive, Sega also tried to keep up with Nintendo's excellence in character design: Sonic the Hedgehog was born as a counterpart to the popular Mario character. It was received well by the player community and generally regarded as more modern and dynamic.



Picture 46: The top-selling game *Sonic the Hedgehog* (1991) and its protagonist – Sega's answer to Mario

Sega sold about 30 million units of the Mega Drive, almost three times as many as of the Master System. In North America, it was marketed under the name Genesis. Although Nintendo's NES remained the most popular console by a slight margin, Sega had successfully managed to gain a foothold on the market, which encouraged several other companies to enter the competition as well.

By now, the problems of 1983 – when newspapers proclaimed that “video games are dead” – were clearly a matter of the past.

## 8.4 Super NES

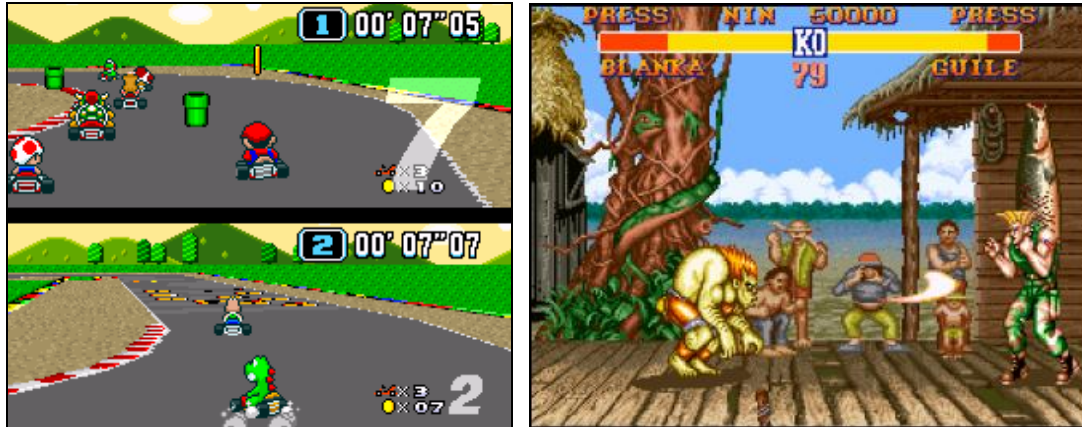
It took Nintendo some time to react to the threat posed by Sega. For two years, the Mega Drive and other consoles were more advanced than the aging NES, whose games – although very well designed and funny – more and more failed to provide players with new experiences. When in 1990 Nintendo released its next console – the Super NES (or “SNES”), which was not particularly advanced in technology – there were doubts whether it could reestablish the company's former undisputed leading position on the market. The SNES' strongest points were its powerful soundchip (developed by Sony) and specialized graphics hardware, which was able to produce a limited type of spatial effects, resulting in exciting racing games. In addition, Nintendo followed a strategy that had repeatedly proven to be successful in the past and would continue to do so in the future: To provide one perfect game, designed to convince customers of the superiority of the console: In this case that game was *Super Mario World* (1990), the successor of the most popular NES game.



Picture 47: Super NES and *Super Mario World* (1990)

Another factor for the success of the Super NES was that many people were by now ready to buy a second or third console. Even if they already owned a Mega Drive or something else,

the innovations found in Nintendo's new games convinced them to buy the Super NES. Popular titles included racing games like *F-Zero* (1990) and *Super Mario Kart* (1992), as well as games of the upcoming "Beat 'em Up" genre like *Street Fighter II* (1992) or *Mortal Kombat* (1992), which were sometimes ports from successful arcade games.



Picture 48: *Super Mario Kart* (1992) and *Street Fighter II* (1992) on the Super NES

Nintendo sold about 50 million units of the Super NES – which surpassed the Sega Mega Drive and became the best selling console of the 16-bit era. In Japan it was sold under the name Super Famicom ("Super Family Computer").

## 8.5 Neo-Geo

The Neo-Geo (released in 1990) by a Japanese company named SNK was a console similar to the Super NES and Mega Drive. It was an advanced console with colorful graphics and high quality sound. While other consoles started to focus on 3D technology, the Neo-Geo is known for perfecting 2D graphics. Its main disadvantage was the high price of both the console and its game cartridges. However, an arcade version of the Neo-Geo was also made and presented several successful game hits, e.g. the *Metal Slug* series and several Beat 'em Up games.



Picture 49: Neo-Geo (1990) and the arcade version of *Metal Slug* (1996)

SNK sold about 1 million units of the Neo-Geo console, which is considerably less than what its competition achieved, but the Neo-Geo arcade version continues to be popular up to this day.

## 8.6 3DO Interactive Multiplayer

The 3DO Interactive Multiplayer (or simply “3DO”) was a console by Panasonic, released in 1993 with high hardware potential, CD-ROM drive and 3D graphics, but too expensive, and only few games were released.



Picture 50: 3DO Interactive Multiplayer (1993) and one of its games, *Alone in the Dark* (1994)

About 6 million 3DO consoles were sold.

## 8.7 Sega Saturn

The Saturn was a good all-round 32-bit console by Sega (1994) with rudimentary 3D graphics, but ultimately could not compete with the successful Sony PlayStation and Nintendo 64. The console was notable for introducing the first 3D Beat ‘em Up game *Virtua Fighter*

(1994), however its untexturized, flat-shaded polygon graphics were soon surpassed by other games.



Picture 51: Sega Saturn (1994) and *Virtua Fighter* (1994)

## 8.8 Sony PlayStation

**SONY**

During the 1980s, Sony Corporation was a company that had already been in the entertainment business for decades and was especially known for its successful Walkman audio devices, but hesitated for some time to enter the new field of electronic games. When in 1994 they released their first console PlayStation in Japan (and one year later in the USA and Europe), the market was dominated by Nintendo, and several attempts made by other companies to compete were unsuccessful. However, there were a few circumstances in favor of Sony: After having provided the sound chip for the Super NES, Sony had already partial experience with console hardware and borrowed many ideas from existing devices. For example, they designed their game controllers to resemble the popular gamepads by Nintendo. In addition, the PlayStation was conceived to include a revolutionary new feature: A CPU capable of geometry calculations for 3D graphics not found in any other console of that time.

The PlayStation evolved to become the most popular console on the market for several years. A large amount of games was produced (about 3,000) and covered all genres of that time. Some of the most popular titles were the 3D Action-Adventure *Tomb Raider* (1996), the Beat 'em Up *Tekken* (1994), the Racing game *Gran Turismo* (1997) and *Metal Gear Solid* (1998)



Picture 52: Sony PlayStation (1994) and *Tomb Raider* (1996)



Picture 53: *Tekken* (1994) and the PlayStation's best-selling game, *Gran Turismo* (1997)

In 2000, Sony released the PSOne, a smaller but otherwise identical version of the PlayStation. The original console and the PSOne taken together sold more than 100 million units.

## 8.9 N64

The Nintendo 64 (or "N64") was Nintendo's third console after the NES and Super NES and was released in 1996. It was the last mainstream console to use ROM cartridges and one of the first to be based on a 64-bit processor, although most games used only the 32-bit mode. Following the tradition of launching the console together with an excellent flagship game, Nintendo included *Super Mario 64* (1996), a modern 3D Platform game with the same vivid and colorful worlds and characters known from the earlier Mario titles. This strategy proved to be successful once again.



Picture 54: Nintendo 64 and *Super Mario 64* (1996)

Nintendo sold about 30 million units of the N64. That was much less than what Sony achieved with their PlayStation, but the N64 reached second place in the market and helped Nintendo keep their reputation as a successful console and game producer.

### 8.10 Dreamcast

The Dreamcast was Sega's last console and very advanced in terms of hardware, comparable to the later GameCube, PlayStation 2 and Xbox. It was the first console to include built-in support for networked multiplayer games over the Internet. The Dreamcast enjoyed considerable popularity for some time, but – as it was previously the case with the Mega Drive – could not live up to its more popular competition.



Picture 55: Sega Dreamcast (1998) and *Virtua Tennis* (2000)

Sega sold about 10 million units of the Dreamcast and also created an arcade version of the console. After that, the company stopped their ambitions in hardware, but continued to make software for other arcade games and other game consoles.

## 8.11 GameCube, PlayStation 2, Xbox

In the early 21<sup>st</sup> century, a new generation of consoles achieved new levels of processing power and graphics quality. Designed to be at least equally capable as modern PCs but available at a lower price and without typical PC problems involving configuration and compatibility, all three were about equally successful, and each of them had their distinctive characteristics:

The principal strength of the Sony PlayStation 2 (2000) is its design as a multi-purpose multimedia device: Apart from being a game console, it can also play audio CDs and view DVD movies. The strong hardware is capable of advanced 3D graphics at a high frame rate and complex calculations needed for realistic kinematics and physics models. Another advantage of the PS2 is its compatibility with the original PlayStation.

Of the three consoles, the PS2 is the one offering most games (about 800). Famous PS2 titles include *Grand Theft Auto III* and games of the popular *Final Fantasy* and *Metal Gear Solid* series.



Picture 56: Sony PlayStation 2 (2000) and *Final Fantasy X* (2001)

The Xbox (2001) on the other hand – Microsoft's first game console – has the most powerful hardware. Its technical similarity to PCs and its use of the well-established DirectX software makes it easy for game developers to port existing games to the console as well as to develop new ones. Xbox games are best known for their impressive audio-visual presentation, the most prominent example being *Halo* (2001). Other notable Xbox games are *Dead or Alive 3* (2001), *Project Gotham Racing* (2001) and *Doom 3* (2005).



Picture 57: Microsoft Xbox (2001) and its flagship game *Halo* (2001)

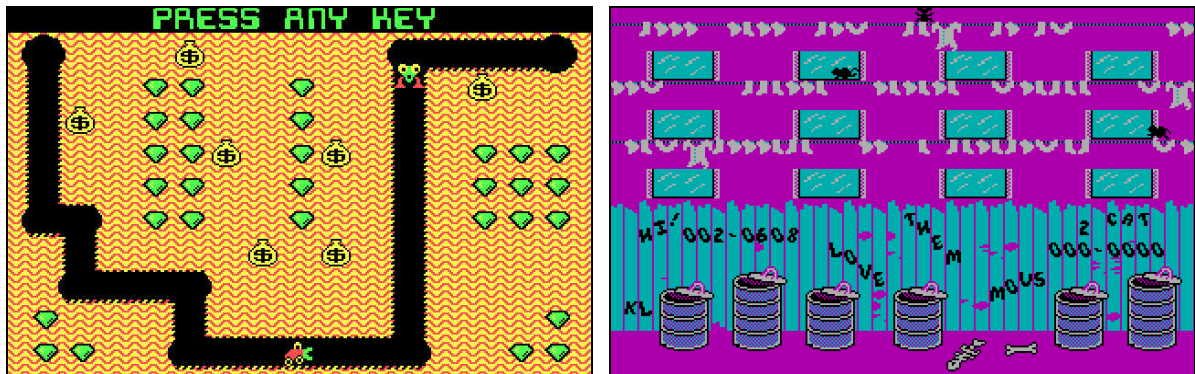
The GameCube (2001) is quite different from its competitors: Instead of building on high-end hardware and cutting-edge visual effects, Nintendo sticks to its traditional image and releases games that emphasize fun gameplay, comic-style graphics and appealing character design. Of the three consoles, the GameCube is technically the least advanced, but on the other hand the most compact and least expensive, which earns it a reputation as a solid alternative to the two “big ones”.



Picture 58: Nintendo GameCube (2001) and *Luigi's Mansion* (2001)

## 9 IBM PC and Compatibles

Of all computer hardware ever used for gaming, the PC was (and is) arguably the most widely used, diversified and long-lasting. The original IBM PC was a single model introduced into the developing home computer market of the early 1980s, designed to compete with the Commodore 64 and the Apple II. The primary strengths of the PC were its successful operating system DOS and its open architecture, which allowed companies to manufacture compatible computers and extensions for the platform, such as hard disks or graphic cards. In the beginning, the PC's biggest problem was that its graphical capabilities were inferior to other systems: The early monochrome and CGA displays were not enough for successful mainstream games.

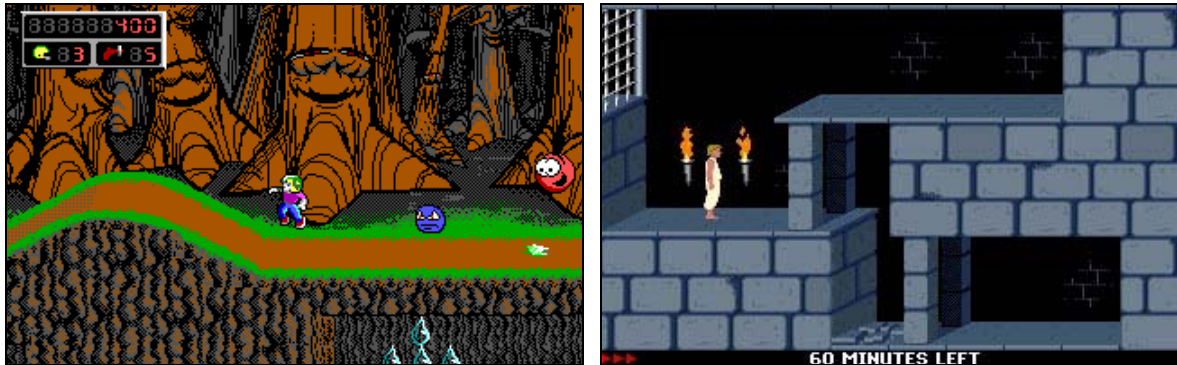


Picture 59: Early PC games in CGA graphics: *Digger* (1983) and *Alley Cat* (1984)

The advent of EGA and VGA graphics technologies soon changed that situation. In addition, PCs were equipped with ever more powerful Intel CPUs like the 286, 386 and 486. By the end of the 1980s, the PC had become a powerful and flexible system widely accepted for games. A few examples of games of that period (all of which have been released on other hardware as well) are the following:

- The *Commander Keen* series of Platform games
- Adventure games (see 11.1), most notably from Sierra Online and LucasArts, e.g. the *King's Quest* series, the *Monkey Island* series, *Indiana Jones and the Last Crusade* and *Leisure Suit Larry*
- *SimCity* (1989): A game about planning and managing a city. *SimCity* introduced a new paradigm of games which can neither be won nor lost. Instead, the objective is about evolution and different challenges over the course of time.

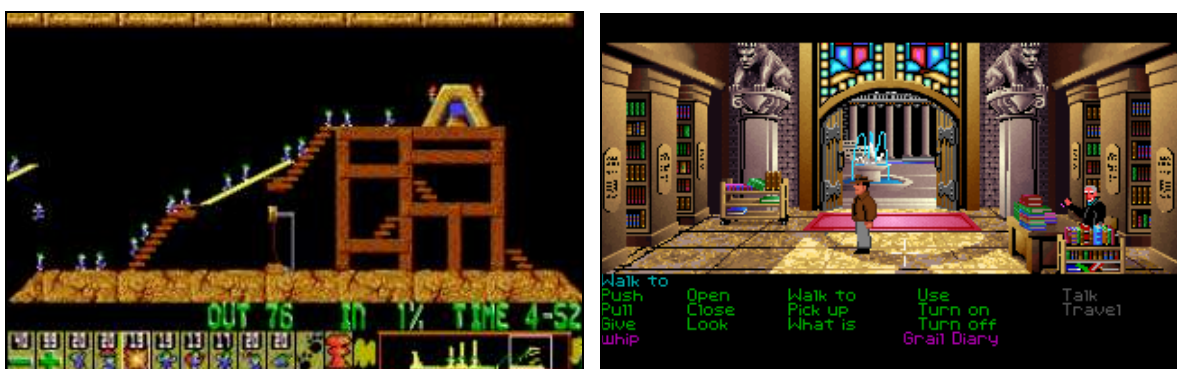
- *Prince of Persia* (1989): Popular Platform game most notable for the realistic animation of its characters.
- *Populous* (1989): A game similar to *SimCity* in which the player assumes the role of a god and controls a world and the civilizations living in it.



Picture 60: *Commander Keen IV: Secret of the Oracle* (1991) and *Prince of Persia* (1989)



Picture 61: *SimCity* (1989) and *Populous* (1989)



Picture 62: *Lemmings* (1992) and *Indiana Jones and the Last Crusade* (1989)

Today the term “PC” refers to a hardware platform compatible to IBM’s original specification. Such “IBM PC compatibles” make up the majority of computers in use and are still a

popular gaming device, despite big competition from consoles. Due to the flexibility of the PC, virtually all kinds of games were developed and could be played on it. The final developments during the 1990s that marked dominance of PCs over both other computers and game consoles were a few new technologies which were especially suitable for the open architecture of the PC:

## **9.1 The Multimedia Revolution**

The Multimedia Revolution refers to the introduction of CD-ROMs and specialized sound cards like the Creative Labs Sound Blaster. CD-ROMs allowed games (which up to that point were often distributed on three, five or even more floppy disks) to utilize large amounts of data space for images, music and videos. Sound cards in turn were able to produce synthesized music and digital sound effects and to play audio contents directly from CD. They replaced the PC Speaker – the PC's internal loudspeaker, which was very limited in its capabilities and not suitable for anything else than simple signal tones. These technologies – apart from qualifying the PC for completely new uses such as music composition – added a new feeling of realism to games.

One of the first big hits to fully utilize the new audio capabilities was the revolutionary 3D space simulation *Wing Commander* (1990), which in its opening sequence featured a virtual conductor directing a symphony. During actual gameplay, exciting sound effects were used for combat elements like gunfire and explosions.

Early examples for games making heavy use of the CD-ROM technology were the Adventures *The 7th Guest* (1992) and *Myst* (1993), which contained highly realistic pictures that were pre-rendered and stored on CD-ROM. *Myst* became the best-selling PC game in history for a few years, but was later surpassed by other titles.



Picture 63: Multimedia Games: *Wing Commander* (1990) and *The 7th Guest* (1992)

## 9.2 3D Graphics

Apart from Multimedia, another trend that could be observed in games during the early 1990s was the introduction of 3D graphics. At first – before specialized 3D hardware was available – programmers invented sophisticated techniques such as Ray Casting to create impressive three-dimensional worlds in which the player can freely move around. The primary genre using these technologies was the First Person Shooter (see 11.6), most popular and influential early games were *Wolfenstein 3D* (1992) and a bit later the more advanced *Doom* (1993), which is one of the best known games in history and resulted in a large wave of imitations.



Picture 64: *Wolfenstein 3D* (1992) and *Doom* (1993)

After these first steps, in 1996 specialized 3D graphics hardware (such as the 3dfx Voodoo) was introduced, which was able to perform fast high-resolution rendering of 3D objects, leading to a new level of realism. The technology was mainly used to further develop First Person Shooters such as *Quake* (1996). This game became very popular after a modified version was released, which made full use of the new hardware capabilities and the emerging OpenGL programming interface.

### 9.3 Multiplayer

Another technology that heavily shaped PC games during the 1990s was the Internet. Apart from introducing the WWW, E-Mail and other services, it also made it possible to play games over world-wide distances. Early Internet connections commonly suffered from low bandwidth and high latency and were therefore only suitable for a limited kind of games. The first games that could be played over the Internet were Multi-User Dungeons (“MUDs”), which are text-based Role-Playing games (see 11.5) and require neither high bandwidth nor low latency. Players usually connect to a MUD using a simple client and protocol such as Telnet, and all interaction takes place by sending and receiving text messages over the network.

```
> unt karte

*** MIDAS ***

      ,0-----0-----0-----0-----0,
    o' 4gw---o  Waffen Laden Apoth. Kaes.  o
      |      |      |      |      |
    o Bank---o-----o-----o-----o
      |      |      |      |      |
(Silberwald) o Kneipe---o Kapelle Laden Post o
      |      |      |      |      |
    )-o-----o-----o-----o-----o-(Ebene)
      |      |      |      |      |
    (Anfaenger park) Rathaus o---HIER! o
      |      |      |      |      |
    o      o      o      o      o
      |      |      |      |      |
    o--Kirche---o'  o'  o'  o'  o'

> unt peacekeeper
Das ist Peacekeeper. Er ist sogar fuer einen Menschen relativ gross, ist
normal gebaut, hat hellbraune Haare und gruene Augen.
Er ist absolut fit.
Peacekeeper hat keine Ruestung an und keine Waffe gezeugt.
> sag hallo
Du sagst: hallo
> Navi sagt: Hallo Peacekeeper.
```

Picture 65: Example of an Austrian Multi-User Dungeon, accessed using the Telnet protocol

One interesting aspect of MUDs is that despite their long history they still enjoy considerable popularity today, having only changed marginally over time.

As the quality and availability of Internet connections increased, more and more games included network capabilities. Multiplayer modes became especially important in the Real-time Strategy (11.4) and First Person Shooter (see 11.6) genres, since in such games the competition against other humans is inherently more interesting and challenging than against computer-controlled adversaries. Today, almost all games of these genres include multiplayer modes. There are even several games which consist only of a multiplayer mode and cannot be played alone, e.g. the team-oriented First Person Shooter *Wolfenstein: Enemy Territory* (2003) or the MMORPG (Massively Multiplayer Online Role-playing Game) *World of Warcraft* (2004).



Picture 66: Multiplayer-only Games: *Enemy Territory* (2003) and *World of Warcraft* (2004)

## 10 Handhelds

Handheld game consoles are light, portable devices for the purpose of playing games. In a similar manner to home consoles, it is possible to distinguish between handhelds with built-in games and handhelds using cartridges or other external storage media.

### 10.1 *Microvision*

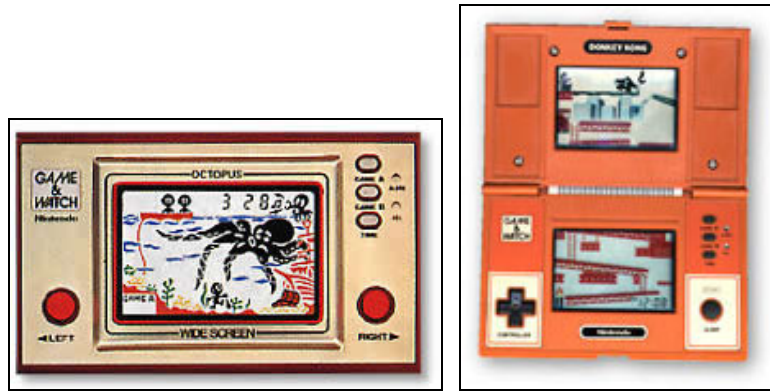
First attempts to create handhelds date back to the late 1970s, one early example is the Microvision, released in 1979 by the Milton Bradley Company. The Microvision had interchangeable game cartridges and was innovative for its time, but not too successful due to its small screen, fragile hardware, high energy consumption and lack of games.



Picture 67: Microvision (1979) by the Milton Bradley Company

### 10.2 *Game & Watch*

Game & Watch was a series of popular handheld devices by Nintendo, which were specifically designed for a single game and differed from each other in appearance and input controls. They were very simple to operate and easy to understand, and their robust hardware and long battery life completed their overall good design, making them the ideal device for quick entertainment.



Picture 68: Game & Watch *Octopus* and *Donkey Kong*

They can be regarded as the predecessors of the Game Boy, as well as Nintendo's first step to its continuous dominance of the handheld market. In German-speaking countries, Game & Watch devices were sold under the name "Tricotronic" and became very successful.

### 10.3 Nintendo Game Boy

The Nintendo Game Boy was an instant hit in 1989 and became the most successful handheld by far. It had an unspectacular design and only a monochrome display without background light, but still was attractive for several reasons:

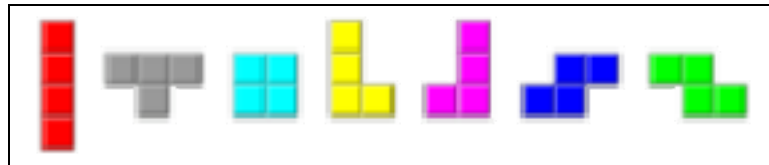
- Due to the simple display, it had very low energy consumption, which proved to be one of the biggest concerns for many players.
- It had simple controls and could be understood easily.
- It had a link cable, which allowed two players to play against each other. This worked with most games and quickly became the handheld's killer application.

In addition and most importantly, there was a special game that shipped with the Nintendo Game Boy: *Tetris*.

#### 10.3.1 Tetris

*Tetris* is said to be the most popular computer game of all time, even more than *Pac-Man* and *PONG*. It is the kind of game that has an extremely simple concept but is still motivating as well as challenging for a long time. While most other games of its time demanded quick reaction and precision of the player, *Tetris* was the first so-called "puzzle game" and had an emphasis on logic and strategy. The game involves seven types of pieces, which are pulled down

by a simple gravity-like force and are in turn each made up of four smaller blocks (in fact, the seven pieces represent all possible combinations in which four orthogonally connected quadratic blocks can possibly be arranged). The player's objective is to move and rotate these pieces, in order to fill rows at the bottom, which then disappear, making room for the game to continue. The game ends when there is no more room on the screen for new pieces to arrive.

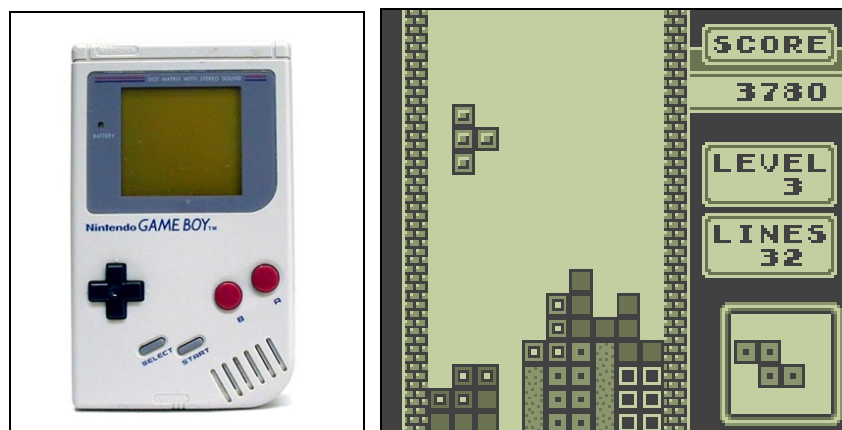


Picture 69: The seven pieces encountered in *Tetris*

Tetris is well known for having been involved in a number of legal controversies. Invented by Alexey Pajitnov of the Soviet Union in 1985, it first gained popularity in Moscow, was ported to the IBM PC and various other platforms in Hungary and then illegally made its way to Western Europe and the United States, where the game became a huge success. Several companies competed over the rights to distribute and modify it, without any approval of the original creators. In the end, Alexey Pajitnov received only little credit and money for his invention.

Another interesting aspect of the game is the influence politics have had on it: The version released in the western world featured Russian themes such as the Red Square or Yuri Gagarin's first space mission, and was sometimes called "the first game from behind the Iron Curtain" and "the Soviet Challenge", which added to the curiosity of western customers.

In 1989, the Nintendo Game Boy and *Tetris* proved to be the perfect combination.

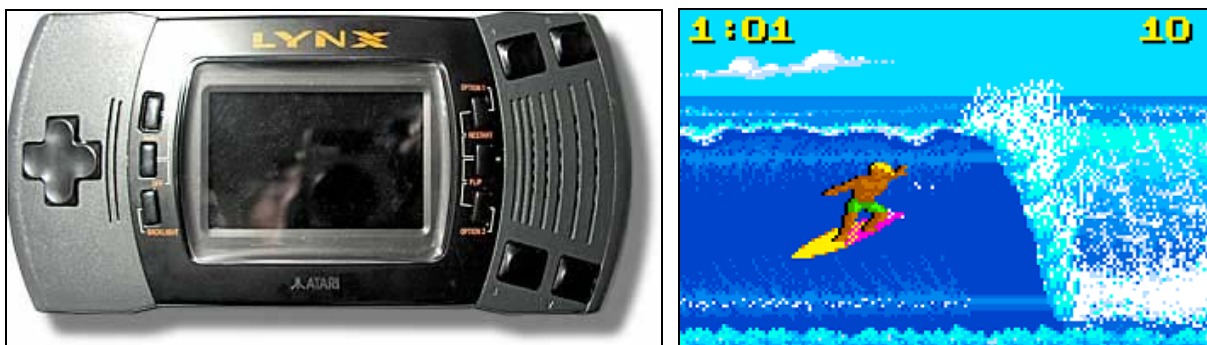


Picture 70: Nintendo Game Boy and *Tetris* (1989)

More than 1000 games were produced for the Game Boy, and it remained popular for over five years. In total, about 70 million units were sold.

### 10.4 Atari Lynx

The Lynx was Atari's attempt to enter the handheld market. Released in the same year as the Game Boy (1989) it was technically much more advanced. In fact, it remained the most powerful handheld for 12 years, until the release of the Game Boy Advance in 2001. The Atari Lynx was the first handheld with a color display and had hardware support for advanced graphical features such as sprite transformation and polygon filling. It even had support for networking with up to 17 other Lynx units. However, its apparent advantages over the Game Boy actually proved to be its downside: Due to the advanced hardware, the handheld suffered from high power consumption, using up six batteries in only four hours. In addition, the Lynx was more expensive, larger, and had fewer games than the Game Boy.



Picture 71: Atari Lynx and the game that shipped with it, *California Games* (1989)

Although technically advanced, the Lynx was no match for the Nintendo Game Boy, and only about 2 millions were sold.

### 10.5 Sega Game Gear

Sega also tried to compete with the Game Boy and released its Game Gear in 1990. Like the Lynx, it had a color display and was held in a “landscape” position. It was technically based on Sega's Master System (see 8.2), which made it simple to convert popular games to the handheld. The Game Gear also had several interesting add-ons that could be bought, e.g. a TV tuner and a magnifying glass.



Picture 72: Sega Game Gear and *Sonic the Hedgehog 2*

The Game Gear was considerably more successful than the Atari Lynx (about 8 million units were sold), but also failed to seriously challenge Nintendo's hold on the market.

### **10.6 Game Boy Color**

After the success of the original Game Boy, Nintendo was in no hurry to develop a new system. Although the company released several modified versions, such as the Game Boy Pocket (1996) or the Game Boy Light (1997), they differed mainly in their size and overall appearance but were otherwise identical to the original.

The next innovative handheld in the Game Boy line was the Game Boy Color (1998), which had a color display, faster processor and more memory, allowing for more modern games. It also had an infrared port which replaced the link cable. In addition, the Game Boy Color was compatible with the original Game Boy – a major advantage considering the large number of games produced.

One game that was (and continues to be) especially popular on the Game Boy Color is Pokémon, a distinctive kind of Role-Playing Game with a strong focus on character development and cooperation with other players.



Picture 73: Nintendo Game Boy Color and *Pokémon Silver* (1999)

About 50 million units of the Game Boy Color were sold, almost as many as of the original Game Boy.

## 10.7 Game Boy Advance

The next major upgrade in the Game Boy line was the Game Boy Advance, which exists in several different versions. It has a larger display than the Game Boy Color and more powerful hardware, comparable to that of a Super NES (see 8.4). Still, it maintains compatibility with both the original Game Boy and the Game Boy Color, which is remarkable considering the hardware changes the system has undergone. The Game Boy Advance also maintains the tradition of the product line to keep power consumption low. Even in spite of its advanced hardware, it only needs 2 AA batteries and lasts for 5-10 hours.



Picture 74: The Game Boy Advance in its original (left) and SP (right) versions

The Game Boy Advance is still being produced. As of 2006, about 70 million units have been sold.

## 10.8 Nintendo DS

The DS (which can stand for either “Developers’ System” or “Dual Screen”) is Nintendo’s latest handheld console and was released in 2004. Compared to the company’s earlier Game Boy systems, the DS has several technical innovations, for example two screens, touchscreen control, a built-in microphone and wireless networking capabilities. This hardware variety has given rise to very different kinds of games and other applications (e.g. the microphone has been used for speech recognition).



Picture 75: The Nintendo DS and *Super Mario 64 DS* (2004), which displays a map on one of the two screens

The DS is compatible to its predecessor Game Boy Advance and can use all its games. It was able to continue Nintendo’s success in the market, and in Japan it became the fastest-selling handheld system ever.

## 10.9 PlayStation Portable

The PlayStation Portable (or “PSP”) is a handheld console by Sony and – although targeted at a slightly different audience – can be seen as a direct competitor to the Nintendo DS. The PSP is most notable for its large color display, intense graphics and high performance. Some games released for this handheld are almost equivalent to their home console counterparts in terms of quality and realism. Using appropriate software, the PSP can even emulate games from other handhelds. Like previous competitors to the successful Nintendo handheld systems, the PSP is superior in terms of processing power and screen quality, but is sold at a higher price and suffers from high energy consumption.

The PlayStation Portable can be used for other purposes than playing games, for example watching videos, listening to music and viewing photos. In addition, it includes Internet functionality, which can be used for both Internet applications and multiplayer games.



Picture 76: The Sony PlayStation Portable and the popular game *Ridge Racer* (2004)

The PSP was first released in 2004. As of 2006, it is estimated that about 20 million units have been sold, which is believed to be slightly less than what the Nintendo DS achieved.

## 11 Notable Genres

Computer games are hard to classify: They differ from one another in many properties, including audio-visual presentation, story, and most importantly in the objective the player has to pursue and the skills required for that. The creativity of game designers as well as diversity in hardware have produced a wide variety of game types and ever new and interconnected ideas. Certain innovations proved to be so successful that they led to the development of whole genres, which continuously evolved and improved over time.

Generally speaking, a genre is a category of games sharing some properties, e.g. the role of the human in the game and the overall goal and challenge of the game.

### 11.1 Adventure games

Adventure games are based on some usually fictional setting and tell a progressing story in which the player actively participates by exploring the world, finding objects and solving puzzles. Another integral part of adventure games is conversation with non-playable characters (NPCs): Dialogues can reveal new information or even result in action critical to the proceeding of the game.

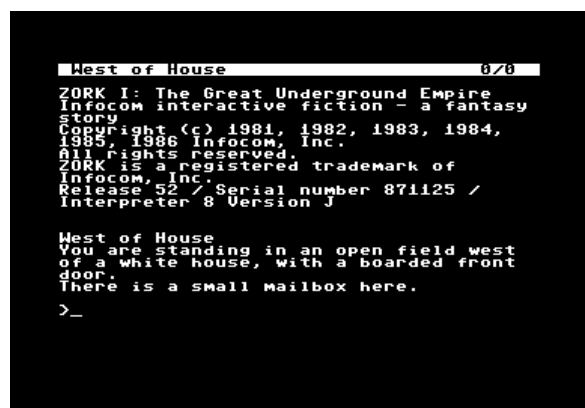
The very first Adventure games were text-based (i.e. required the user to enter sentences with the keyboard) and playing them – similar to reading a book – required fantasy and imagination. After some time, adventure games evolved to contain graphical presentations of the world, and even later more complex user interfaces instead of simple text-based interaction.

In the mid-1990s Adventure games lost much of their popularity, the main reason being the rise of other genres such as First-Person Shooters and MMORPGs (Massively-Multiplayer Online Role-Playing Games).

Zork I: The Great Underground Empire	1980, Infocom
--------------------------------------	---------------

Platforms: Apple II, C64, PC (DOS), others

- One of the first purely text-based Adventures.
- Sparked several sequels.



## Mystery House

1980, On-Line Systems (later: Sierra Online)

Platforms: Apple II

- First adventure game ever to contain graphics (two-dimensional drawings).



## King's Quest I: Quest for the Crown

1984, Sierra Online

Platforms: various

- First adventure game to contain a controllable, graphical representation of the player's character (i.e. third person view).
- Similar games include: *Space Quest* series, *Police Quest* series, *Leisure Suit Larry* series.



## Maniac Mansion

1990, LucasArts

Platforms: various

- Adventure game that popularized a point-and-click interface, in which the player performs all interaction by combining a verb (such as “Open” or “Give”) with an object and sometimes a person (i.e. “Open door” or “Give key to Dave”). Therefore, the game is mainly played by formulating natural sentences which result in reactions in the environment.



- Includes multiple playable characters and possible endings.
- Similar games include: *Monkey Island* series, *Indiana Jones* series, *Day of the Tentacle*, *Zak McKracken and the Alien Mindbenders*.
- Later LucasArts adventures introduced the idea that the player cannot die or get stuck at any moment in the game, making it possible to fully enjoy the challenges presented by the world without the fear of making a mistake or the constant need of saving the game.

Myst

1993, Brøderbund

Platforms: PC (Windows), Macintosh, 3DO

- First adventure with photorealistically rendered 3D scenes. Also one of the first games using CD-ROM as its storage media.
- Criticized for overly emphasizing technology over gameplay.



Syberia

2002, Microids

Platforms: PC (Windows), PlayStation 2, Xbox

- One example of the few “modern” adventure games.



## 11.2 Platform games

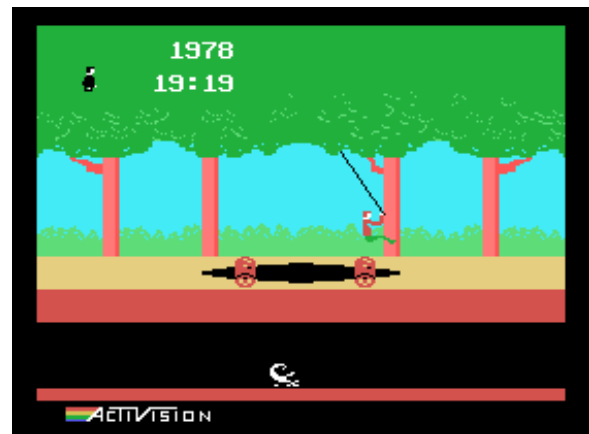
In Platform (or “Jump&Run”) games, players control their character to climb up and down, walk around and jump to and from platforms and ledges. The tasks in early Platform games usually included exploring the world, avoiding enemies and reaching the end of the level. Later games added more “active” components like collecting items and fighting enemies, with a varying degree of displayed violence.

Pitfall!

1982, Activision

Platforms: Atari 2600, ColecoVision, various others

- Depending on the exact definition, Pitfall! can be considered to be the first game of the Platform genre.



Congo Bongo

1983, Sega

Platforms: Arcade game

- An early arcade game of the Platform genre, which – although not particularly successful – was notable for its innovative isometric view of the world.
- The player’s task is limited to avoiding enemies and jumping over rivers/holes/obstacles.



Platforms: NES/Famicom

- First game in a popular series, Super Mario Bros set standards in the Platform genre and became one of the best selling video games ever.
- Set in a vivid, colorful world, the game provides a motivating and fun atmosphere, while avoiding the display of excessive violence found in many other games.
- Also notable for its excellent character design and for popularizing the famous Mario character.



Platforms: PC (DOS), various others

- Prince of Persia combines the popular Jump&Run genre with ideas taken from Adventure and Role-playing games and provides the player with a suspenseful and motivating atmosphere.
- Known for the highly realistic and fluid movement animations of the characters, achieved by an early form of motion capturing (a technique where life movements of actors are captured with a camera and then translated to video game characters).
- First computer game to introduce an innovative “life meter” (a line of symbols depicting the hero’s health status), which proved to be an immensely successful game feature and became an integral component of many other games.



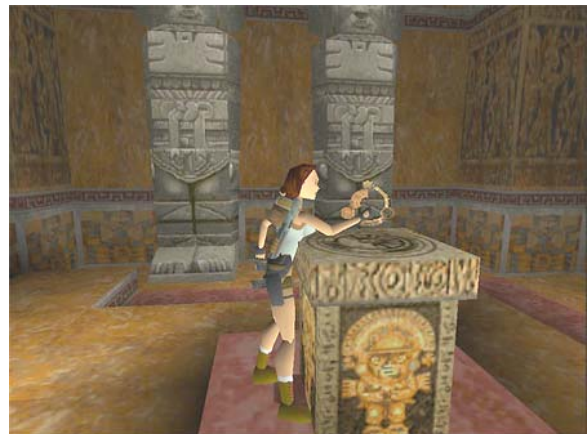
Platforms: Nintendo 64

- The game that shipped with the Nintendo 64 and set the standard for 3D Platform games.
- Because it is set in a huge world, the main emphasis of the game is exploration, yet the familiar features of 2D Platform games such as collecting items and fighting enemies are well preserved.



Platforms: PC (Windows), PlayStation, various others

- First game of the popular Tomb Raider series.
- Highly influential game in the Platform genre which included elements from other genres as well (e.g. First Person Shooter, Adventure).
- Well known for its main protagonist, Lara Croft, Tomb Raider was one of the first games to spark off a huge media franchise including several Hollywood movies.



Platforms: PC (Windows), Xbox, PlayStation 2, GameCube

- Modern 3D Platform game which adds many new features to the original genre, e.g. puzzle solving and advanced combat.
- Just like the original game of the Prince of Persia series, The Sands of Time is known for fluid game mechanics and animations, excellent visual design and good story-telling.



### 11.3 Shoot 'em Ups

In this genre a lone hero starship (or alternatively, a helicopter, airplane or similar vehicle) is set against a huge army of adversaries. The player's objective usually focuses on quick shooting and evading enemy fire rather than on planning and sophisticated strategy. Started by *Space Invaders*, Shoot 'em Ups initially achieved high popularity as arcade games and later spread to other platforms as well.

Platforms: Arcade game

- Considered to be the game that started the genre.
- Single-screen game with limited movement possibilities.
- Similar games include *Galaga* (the first ever color arcade game) and *Galaxian*.
- First game ever to display high-scores on the screen.



1942

1984, Capcom

Platforms: Arcade game

- Shoot 'em Up game set in the World War II Pacific Theatre, modeled after actual historical places and events.
- Advanced features such as varying weapons, “boss” enemies and free movement on the whole battlefield.



Raptor: Call of the Shadows

1994, Apogee Software

Platforms: PC (DOS)

- Vertically scrolling Shoot 'em Up especially popular for its graphical realism.
- Similar games include *Xenon 2*, *Tyrian* and *Starscape*.



R-Type

1987, Irem

Platforms: Arcade game, various

- One of the most popular horizontally scrolling Shoot 'em Ups.



## 11.4 Real-Time Strategy

Real-time strategy games are war simulations in which the player has to cover a variety of tasks on the strategical level (resource gathering, base management, technological research) and tactical level (attacking, defending, giving orders to individual military units). The game progresses in “real-time”, i.e. continuously, and the player sometimes has to be fast to react to sudden changes.

This genre arguably started with *Stonkers* in 1983 and became most popular during the 1990s on the IBM PC.

Stonkers

1983, Imagine Software

Platforms: ZX Spectrum

- First game to include the classic elements of RTS, i.e. armies consisting of individual units and tactical combat on an abstract map.



Dune II

1992, Westwood Studios

Platforms: PC (DOS)

- Considered to be the game that set the de facto standard for the genre.
- Pioneered many features found in modern RTS games, e.g. base development, resource gathering and different “races” to choose from.



## Command & Conquer: Red Alert

1996, Westwood Studios

Platforms: PC (DOS)

- Introduced many new ideas and – together with *Warcraft*, *Warcraft II* and *Starcraft* – cemented the RTS genre.



## Starcraft

1998, Blizzard Entertainment

Platforms: IBM PC

- Award-winning game known for its excellent multiplayer mode.
- Considered to have had a big influence on the development of E-Sports (playing games as competitive sports).



## Warcraft III: Reign of Chaos

2002, Blizzard Entertainment

Platforms: IBM PC

- First successful 3D RTS.



## 11.5 Role-Playing Games

Traditional (non-electronic) Role-Playing Games involve several participants who assume the roles of characters and collaboratively create stories. They find themselves in a (usually fictional) world and use their imagination (and typically simple tools such as pens, paper and dice) in order to progress in the game. Out of this type of game, an electronic game genre has evolved which keeps most of the original characteristics.

RPGs require the skill to mentally immerse into the presented world and into the character one represents in order to be successful in the game. Therefore they are similar to Adventures and may even have been influenced by that genre, but usually also involve some kind of combat element, more interaction between characters and generally a more time-driven environment in which the right actions have to be taken at the right time. Also, the development of one's own character is much more important and usually contains traits such as profession, race and skills.

First purely text-based, they later included graphics and eventually even led to the creation of a new sub-genre involving a networked multiplayer mode: MMORPGs (Massively Multiplayer Online Role-Playing Games).

dnd

1974, Richard Garriott

Platforms: Apple II

- One of the first RPGs; already included most features associated with this genre, e.g. character development, world exploration, items, spells and combat with various monsters.
- Also the first game ever to include a “boss” (i.e. a special enemy at the end of the game, typically far stronger than any encountered before).



Platforms: Apple II

- First RPG in the successful Wizardry series.
- Still mainly text-based, but included graphics to illustrate enemies.



Ultima III: Exodus

1983, Richard Garriot

Platforms: PC (DOS), C64, various others

- Third game in the popular Ultima series, considered to be one of the most influential games ever.
- Contained many innovations that became standards in RPGs, e.g. the concept of quests and a consistent storyline extending throughout the whole game.



Diablo

1997, Blizzard Entertainment

Platforms: PC (Windows), Mac OS, Sony PlayStation

- First popular multiplayer RPG with an emphasis on fast action.



Platforms: PC (Windows), Apple Macintosh

- Very successful MMORPG involving hundreds of thousands of players in a huge world, encompassing a wide variety of landscapes, races, cities and events in a fantasy setting.



## 11.6 First Person Shooters

First Person Shooters view the world from the playable character's point of view. The player can freely move around in various environments and usually has to employ an array of hand-held guns and other weapons to kill large amounts of enemies (e.g. monsters, other humans, aliens, etc), while at the same time avoiding damage to himself. The ultimate goal is usually to find some location in the level (e.g. an exit), solve some puzzle or to generally progress, although the main aspect of the game is always fighting.

Combinations with other game genres do exist and are sometimes given distinctive sub-genre names such as "tactical shooter" or "first person adventure". Examples are *Counter-Strike*, *Ultima Underworld* and *Descent*.

The FPS genre is known for its pursuit of realism and the resulting ever-improving use of graphics technology: One of the main characteristics of FPS games has always been the accurate visual presentation of the world the player acts in, which is essential for creating an atmosphere of suspense. Advances in this genre have influenced developments in the field of 3D computer graphics and vice-versa.

First Person Shooters continue to be criticized for the amount of violence involved, a distorted view of reality (e.g. the unrealistic amount of damage the player can sustain) and for lack of dealing with moral values (i.e. no or insufficient justification of the player's actions).

Platforms: PC (DOS), various others

- Generally regarded as the game that first popularized the FPS genre, Wolfenstein 3D received high acclaim from both players and the press.
- Compared to later games, it had several technical limitations in the modeling of the 3D world (only perpendicular walls, no varying room height, no texture mapping on floors and ceilings).
- Part of Wolfenstein 3D's huge success was its distribution model (Shareware): The first episode of the game (10 missions) could be copied freely.



Platforms: PC (DOS), various others

- The biggest milestone in FPS history, Doom introduced many new features and set the standard for several years. Before the term “First Person Shooter” was coined, games of this genre were simply called “Doom clones”.
- Extensive use of 3D techniques such as texture mapping and lighting.
- Improvement of the modeling of the world (e.g. varying floor heights, non-perpendicular walls).
- Pioneered a networked multiplayer mode, in which players can solve levels in a cooperative way or compete against each other (“Deathmatch”). This feature would later prove to be essential for FPS games.



- Also known for storing its data files in an extendable structure, allowing players to create their own levels and other additional features.

Quake

1996, Parallax Software

Platforms: PC (Windows), Apple Macintosh, N64, various others

- Another classic FPS that set many standards for later titles.
- Included a “true” 3D world without limitations to its geometry as found in earlier games (i.e. levels could now consist of arbitrarily constructed flat surfaces).
- Popularized the “free mouse look” paradigm into the genre.
- Enemies were now displayed as 3D models instead of simple 2D sprites.
- Also included a networked multiplayer mode, which was now a much more important part of the game than it had been in *Doom*.
- Similar to *Pac-Man* (see 4.2), *Quake* has also inspired players to extensively analyze the mechanics of the game. One example of this is the development of so-called “Speedruns”, i.e. attempts to complete the whole game within a very short time by mastering and exploiting game mechanics to a maximum.
- Also known as a good example for the relation between software and hardware development: Like many other games, *Quake* pushed existing hardware to its limits, forcing many players to buy new suitable computer equipment. *Quake* was also one of the first games to use 3D acceleration hardware for achieving higher speed and realism.



## Counter-Strike

1999, Valve Corporation

Platforms: PC (Windows), Xbox

- Highly popular (and controversial) modification of the Half-Life FPS.
- Pure multiplayer game that highlights the suitability of the genre for network play.
- Known for introducing a new sense of realism (e.g. of weapons and resulting damage) into the genre.



## Half-Life 2

2005, Valve Corporation

Platforms: PC (Windows), Xbox, Xbox 360, PlayStation 3

- One example for a modern FPS making extensive use of 3D acceleration hardware for realistic visual presentation of the world.
- Also highly realistic in fields other than graphics (e.g. physics, artificial intelligence).



## 12 Recent Developments and Outlook

### 12.1 Realism

Nearly all computer and video games in history are in one way or the other simulations of familiar activities. Since *PONG* – a simulation of table tennis – game developers have tried to more and more increase the level of realism of characters, worlds and game mechanics. This realism was traditionally achieved mainly by improving graphics, but during the last years the striving for realism affected other game elements as well, for example:

- **Physics:** People, vehicles and various objects in games tend to be modeled so they are more realistically affected by physical forces like gravity and acceleration. Weapons, weather and interactions such as collisions are also portrayed based on realistic models.
- **Artificial Intelligence (A.I.):** The behavior of opponents was a weakness in early First Person Shooters. While graphics looked impressive, the enemies opposing the player were usually acting in simple patterns, which could easily be understood and predicted after some time of playing. In contrast, modern FPS games usually contain complex A.I. models, which result in unexpected and surprising situations and ever-new tactical challenges. Improved A.I. is also an important factor for other genres, e.g. Real-time Strategy.



Picture 77: A vehicle moving based on a realistic physical model (left) and intelligent, cooperating enemies (right)

### 12.2 New Genres

Another trend that can be observed is the creation of new game genres and the combination of existing ones. One component that is especially evolving to support new kinds of games is networked play. With the availability and quality of Internet access constantly improving, it

has become possible for millions of players to interact with each other in a shared environment. The most popular genre using such “MMO” (massively multiplayer online) technology is the MMORPG (MMO Role-Playing Game), which has produced several successful games, e.g. *Everquest* (1999), *World of Warcraft* (2004). However, other genres have also been extended to involve large numbers of players, for example:

- MMORTS (MMO Real-Time Strategy): One example for a Real-Time Strategy game in a large-scale, persistent world is *Shattered Galaxy* (2001). In contrast to “normal” RTS games, players do not control whole armies, but only a handful (e.g. 6-12) of specialized units, therefore it is important to join forces with other players in order to complete “traditional” missions, e.g. conquest of enemy territory.
- MMOFPS (MMO First Person Shooters): The first MMOFPS was *World War II Online* (2001), a huge simulation of a virtual battlefield, involving thousands of players, who assume various fighting roles such as infantry, gunners, pilots and tank commands. The game involves a lot of team play and even has components reminiscent of other genres, e.g. people can play the roles of high ranked soldiers and lead missions or define strategic goals.



Picture 78: The MMORTS *Shattered Galaxy* (2001) and the MMOFPS *World War II Online* (2006)

## 12.3 New Ways of Interaction

Traditional games use a screen and loudspeakers for audio-visual presentation and devices such as joysticks/mice/keyboards for accepting user input. There have been several attempts to extend the range of both output and input devices to produce unusual effects or to require the player to perform new kinds of action. Examples are:

- Tracking devices. There have been several attempts to build input devices which track player location and movement, in order to achieve a wide range of possible interaction with the game. The most popular device of this category is the Sony EyeToy, a digital camera which uses image processing to track motion and color. In typical EyeToy games, players have to use their hands and feet to hit or manipulate objects in the game; the results of such interaction are shown on the screen.



Picture 79: The Sony EyeToy and a player trying to hit game elements with her hands

- Music Video Games (or „Rhythm Games“), i.e. electronic games with a strong audio component. The challenge for the player is to stay in rhythm with the game’s music and trigger input devices such as dancing pads or drums in time with the beats of the music, following a certain pattern presented by the computer. The most notable game using dancing pads is *Dance Dance Revolution* (1998). A more recent example, which involves two drums, is the GameCube game *Donkey Konga* (2004). Many Rhythm Games exist both as arcade and home console versions.



Picture 80: Dancing pad for *Dance Dance Revolution* and drums for *Donkey Konga*

- Systems using multiple peripherals for producing unusual effects such as sophisticated lighting, colors and even temperature and airflow. For example, the amBX system by Philips (planned to be released in 2007) uses a range of lights, loudspeakers, fans, heaters and other devices to produce a full “sensory” experience for music, movies and video games.

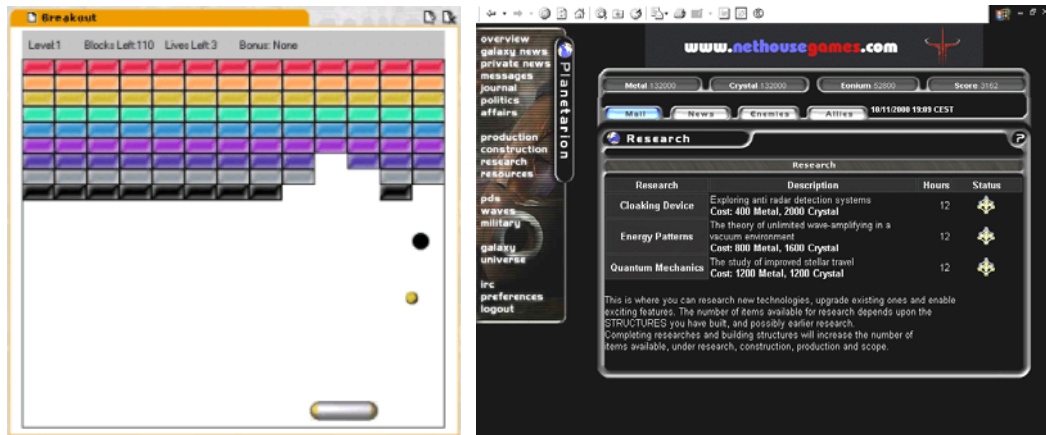


Picture 81: The Philips amBX system uses fans and advanced lighting and color effects

## **12.4 Browser-based games**

With the advent of the Internet, it has become possible to play games without the need for installing client software on one's computer. Instead, such games can be played in a web browser, utilizing various Internet technologies. Simple games such as card or puzzle games are purely client-based and use JavaScript, Java, Shockwave or Flash. More complex games however employ client-side technologies only for presentation and establish the actual game framework using communication with a server, which allows for more complex game behavior and even multiplayer functionality. Multiplayer browser-based games are mostly Strategy or Role-playing games, but can involve other genres as well.

Browser-based games are simpler and more limited than standalone games, but they are easily accessible, making them ideal for casual gaming.



Picture 82: Browser-based games: A simple Java game (left) and *Planetarian* (right), a multiplayer strategy game using CGI for server communication

## 13 Timeline

1889

- Founding of Marufuku Company (renamed to Nintendo in 1951) to manufacture Japanese playing cards.

1933

- Building of the first electric pinball game called *Contact*.

1947

- A United States patent is filed for an unnamed game on a “cathode ray tube amusement device”. It is a simulation of a missile fired at various targets (see 3.1).

1952

- Creation of the first game to use a graphical display: *OXO* a simulation of Tic-Tac-Toe (see 3.2).

1958

- Invention of *Tennis for Two* (see 3.3). It is a simulation of a match of table tennis and played on an oscilloscope.

1954

- Sega is founded by a former American Korean War veteran.

1961

- A student at the Massachusetts Institute of Technology (MIT) creates *Spacewar!* (see 3.4)

1967

- Ralph Baer succeeds in creating the first interactive TV games – among them *Table Tennis*.

1971

- *Computer Space*, created by Nolan Bushnell and Ted Dabney, becomes the first arcade game ever released. Public opinion is that it is too difficult to play.

1972

- An American patent is issued to Ralph Baer for "A Television Gaming Apparatus and Method". Magnavox begins manufacturing the TV game system called Odyssey.

- After *Computer Space* earns only mediocre popularity because of its difficulty, its creators found Atari and envision simpler games. The first game created by Atari is *PONG*, which is very easy to play and becomes an instant success.

1975

- A home version of Atari's *PONG* is released. It becomes the best-selling Christmas present of this year.

1977

- Atari introduces its first cartridge-based home video system called the Video Computer System which later becomes known as the Atari 2600.

1978

- Midway introduces *Space Invaders* into arcades. The game is recognized as being the one that started the “Golden Age of Arcade Games”.
- Magnavox releases the Odyssey2, a programmable console that has a built-in membrane keyboard.

1979

- Namco releases *Galaxian*, the first color arcade game (without using overlays).

1980

- Mattel's Intellivision debuts and is the first real competitor of the Atari 2600. It has better graphics than Atari's 2600, but a higher retail price.
- Activision becomes the first third-party video game vendor. The company is created by Atari programmers who want to receive individual credit for creating Atari's video games.
- 300,000 units of *Pac-Man*, the most popular arcade game of all time, are released worldwide by Namco.

1981

- Founding of the first video-game magazine, Electronic Games.
- A man dies of a heart attack while playing Berserk – the first known game to be blamed for an actual player's death.

1982

- Atari releases the Atari 5200 to compete with Coleco's ColecoVision.

1983

- The Commodore 64 is introduced. It is the most powerful video-game console to date and the least expensive.
- Nintendo introduces the Famicom in Japan – later known as the Nintendo Entertainment System (NES) in the USA.
- Decline of arcade games and home consoles: Too many products, low quality and the rise of home computers cause a temporary loss of interest in games.

1985

- The popular game Tetris is developed by Russian programmer Alex Pajitnov. After being ported to the PC platform, it becomes highly successful and at the same time sets off one of the biggest legal struggles in gaming history.

1986

- After having been test-marketed in New York City one year earlier, Nintendo's NES is released nation-wide in the USA.
- To compete with the NES, Sega introduces its console Master System.
- Atari releases the Atari 7800 to stay competitive in the market.

1989

- Nintendo releases the handheld Game Boy, which comes with the popular game Tetris.
- Sega tries to keep up with Nintendo with its Genesis, its first 16-bit home game console.
- Atari tries to enter the handheld market with the Lynx, a technically advanced handheld console.

1990

- Release of the NeoGeo by SNK.

1991

- Super NES is released in the USA by Nintendo.
- Sega introduces Sonic the Hedgehog, the counterpart hero to Nintendo's Mario.

1993

- Atari releases the Jaguar, attempting to be the first 64-bit console on the market. The product actually runs two 32-bit processors.
- Politicians in the USA launch an investigation into violence in video games, hoping to initiate a ban on violent games. As a result, the Entertainment Software Rating Board is created. Ratings are now given to video games and are marked on the games' packaging to indicate the suggested age of players and violent content.
- In Japan, the Sega Saturn and the Sony PlayStation make their debut.

1995

- Sony brings the PlayStation to the USA.
- Nintendo releases the Nintendo 64 in Japan and one year later in the USA.

1996

- The Tamagochi virtual pet becomes an instant sensation in Japan. It is released in the U.S. in May of that year selling all of its 30,000-unit supply in 3 days.

1997

- PlayStation is considered by many in the industry as most popular game console as the 20 millionth unit is sold.

1998

- Sega introduces the Dreamcast in Japan.
- The Rhythm game Dance Dance Revolution is released in Japan.
- Nintendo introduces the Game Boy Color.

1999

- Billy Mitchell attains a score of 3,333,360 in the game Pac-Man. This is the highest possible score a player can get.

2000

- Sony's PlayStation 2 launches in the USA and becomes an instant success.

2001

- Microsoft releases its Xbox.
- Nintendo releases the GameCube and Game Boy Advance.

2004

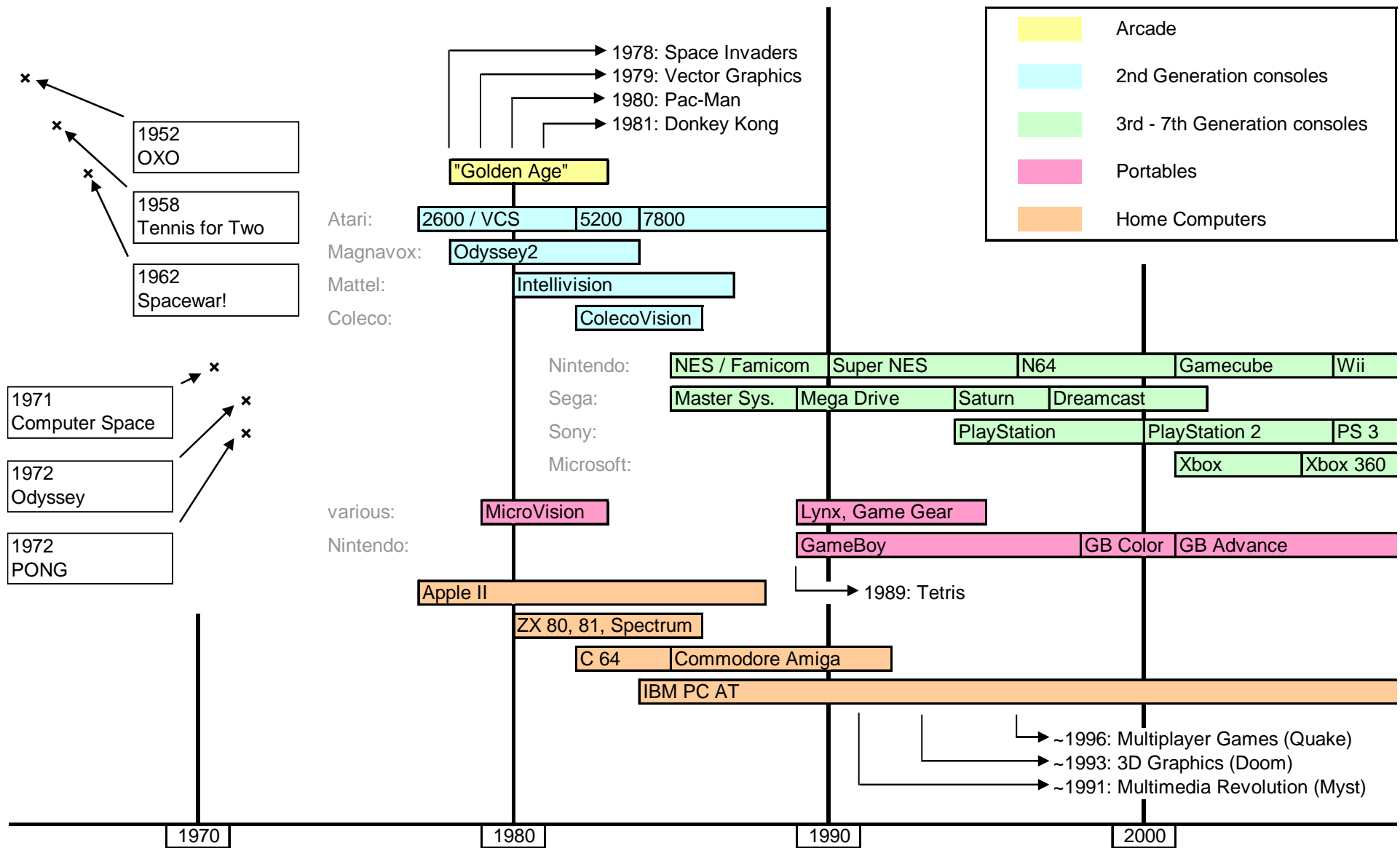
- Nintendo releases the Nintendo DS, a portable system with two screens, one of which can be used as a touch screen.

2005

- Sony releases the PSP, a portable system with a large, high-resolution display.
- Microsoft releases its latest console, the Xbox 360, in an attempt to stay ahead of Sony and Nintendo.

2006

- Nintendo and Sony release their latest console systems Wii and PlayStation 3, respectively.



## 14 “High Scores” in Game History

The following tables list some interesting records and milestones in the history of electronic games:

General	
first electronic game	Unnamed missile game (1947)
first arcade game	Computer Space (1971)
first video game	Tennis for Two (1972)
first computer game	OXO (1952)
best selling arcade game	Pac-Man (Namco, 1979)
best selling video game	Super Mario Bros. (Nintendo, 1985)
best selling computer game	The Sims (Maxis, 2000)
best known game (estimated)	Tetris (various publishers, first 1985)
first discussion of violence in games	Death Race (Exidy, 1976)
first game designed by a woman	Centipede (Atari, 1980)
first game to include a “boss”	dnd (1974)

Technology
------------

first game to use a microprocessor	Gun Fight (Midway, 1975)
first game to display high scores	Space Invaders (Taito, 1978)
first game to allow high scorers to enter three letters of their name	Asteroids (Atari, 1979)
first color arcade game	Galaxian (Namco, 1979)
first game to introduce a virtual world	Defender (Williams Electronics, 1980)
first 3D arcade game	Battle Zone (Atari, 1980)
first game with synthesized voices	King and Balloon (Namco, 1980)
first game with parallax scrolling	Moon Patrol (Williams, 1982)

Genres
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first Adventure game	Adventure (1976)
first Platform game	Donkey Kong (1981)
first Role Playing game	Dungeon (1975)
first First Person Shooter	Maze War (1973)
first Real-time Strategy game	Stonkers (1983)

## **15 Project Softwaremuseum**

This chapter describes an interactive installation made for the exhibition „medien.welten“ at the „Technisches Museum“ (Museum of Technology) in Vienna. The exhibition is concerned with all kinds of media technology – from postal services and simple telecommunication to technologies involving images, sound, printing and data processing. It tells the story of these various kinds of media and how they have become increasingly interconnected. The „Softwaremuseum“ is an interactive installation where information about the history of computer games and other software is presented, and where visitors can try out a few games themselves.

### **15.1 Goal**

The goal of the „Softwaremuseum“ was to give a representative and comprehensive overview of the history of electronic games. Users of the installation can view video clips, sounds, texts and a list of games which can be started and played interactively.

### **15.2 My job in the project**

During the course of the project Softwaremuseum, my tasks involved the following:

- Collect information about electronic games and their history.
- Formulate criteria for selection of a few games to be included in the project.
- Choose appropriate games according to the found criteria.
- Design and implement hard- and software to drive the interactive installation. Note: The requirements and software design changed considerably during the project; only the final (implemented) version will be described here.

### **15.3 Technical description**

Essentially, the Softwaremuseum has to perform two fundamentally different tasks: Display non-interactive multimedia content about electronic game history, and execute games which can be played interactively. The installation was therefore designed to consist of two separate personal computers which would be connected via a TV cable (transmitting a PAL signal) and a 10 Mbit standard Ethernet network cable.

The first machine (called the “Master”) provides the primary interface for the user. The second (called the “Slave”) is responsible for running games. Coordination between these computers is achieved with a custom TCP/IP protocol (see 15.4).

### 15.3.1 The Master

The Master is connected to a video projector and responsible for producing the main visual output for users of the “Softwaremuseum”. Most of the time, it displays a user interface implemented in Macromedia Director 8.5. This user interface can be controlled using a trackball and allows for the following actions:

- Browsing through a timeline and viewing events relevant to software history.
- Accessing information about relevant hard- and software.
- Viewing video clips and other multimedia content.
- Starting one of the available games.

Summary: Tasks and technologies on the “Master”

Operating system:	Microsoft Windows 2000 Professional
Implementation of the user interface:	Macromedia Director 8.5
Displaying the incoming TV PAL signal inside the user interface:	VideoSprite Xtra 3.0 Plug-in for Macromedia Director 8.5 (based on Microsoft DirectShow)
Sending commands to the slave:	Custom TCP/IP network protocol
User interaction:	Logitech trackball

### 15.3.2 The Slave

The Slave is responsible for starting the historic games after instructed to do so by the Master (i.e. after the user selects one of the games on the user interface). The visual output of those games is not displayed directly; instead it is transmitted to the Master using a TV cable, where it is viewed in a window, typically surrounded by an appropriate graphical decoration. For

instance, when Tetris is launched, the game screen appears to be surrounded by the Game Boy handheld device, supporting the original “look and feel” of the game. The tasks of the Slave machine (i.e. starting and stopping of games) are performed by a specially developed Windows application.

Since the selected games are mostly not native IBM PC programs, so-called emulation software (see 15.6) is required to run them.

In some games, it is necessary to perform certain actions (such as keystrokes or mouse clicks) before the game actually starts (i.e. to skip an introduction or a menu). These actions are performed automatically by the server software once the game has started, so that the user can begin playing right away, without the need for any intermediate input.

The input device connected to the Slave is a Microsoft Sidewinder gamepad, which is used for playing all games.

Summary: Tasks and technologies on the “Slave”

Operating system:	Microsoft Windows 2000 Professional
Server software:	Custom Windows application implemented in Microsoft Visual C++ 6.0
Starting and stopping games:	Windows API ( <i>CreateProcess</i> , <i>SendMessage</i> , <i>TerminateProcess</i> )
Sending custom commands to individual games in order to start playing right away:	Windows API ( <i>SendInput</i> )
Starting games not compatible with the IBM PC Platforms:	Various emulation software
User Interaction:	Microsoft Sidewinder gamepad

### 15.3.3 Typical usage scenario

The following could be a typical usage scenario of the Softwaremuseum:

1. The Master displays the user interface consisting of a timeline and several clickable hotspots. The Slave is idle, waiting for commands from the Master.
2. A user starts interacting with the Softwaremuseum interface using the trackball connected to the Master.
3. After some time of browsing through the available videos, sounds and texts on the Master, the user decides to play one of the historic games and clicks on the icon symbolizing the game “Tetris”.
4. The Master initiates a TCP/IP connection to the Slave and sends a command to start the game Tetris.
5. The Slave checks if any game is running at the moment (if yes, it is stopped).
6. The Slave starts the game Tetris using the emulation software VisualBoyAdvance and sends some keyboard input to skip the menu.
7. The Slave sends a reply to the Master that the requested game is running now.
8. The Master switches from its default user interface to a “game mode” and displays the game (i.e. the video signal received from the Slave via a TV cable) in a window. The window is nicely surrounded by an image of the Game Boy handheld device.
9. The user now uses the gamepad connected to the Slave to play the game.
10. After some time of playing, the user decides to end the game and uses the trackball to click on a button in the user interface.
11. The Master sends a command to the Slave to stop the game.
12. The Slave stops the game and sends a reply to the Master.
13. The Master leaves “game mode” and returns to its normal user interface. The Slave becomes idle. The user may continue to explore the Softwaremuseum using the trackball again.

## **15.4 Network protocol**

This protocol is used for communication between the „Master” and „Slave” computers in the Softwaremuseum installation. When a user selects a game for playing, the Macromedia Director Interface running on the “Master” computer uses the protocol to instruct the “Slave” to start the desired game. When the user finishes playing or after a timeout expires, the currently running game can be stopped.

### **15.4.1 Connection**

The protocol uses a TCP/IP connection on port 19725. Server software running on the Slave machine listens on this port for incoming connections from the Master. If at the time a connection is made another connection exists already, the old one is closed and the new one accepted.

After a connection is established, the Slave waits for commands from the Master. The exchanging of messages is modeled on a simple request/response pattern, in which the Master sends a text-based message requesting a certain action and the Slave replies whether the desired action succeeded or failed.

No attempt for keep-alive messages or similar error-detection techniques is made, since the Master machine may at any time open a new connection to the Slave in case any problems occur.

### **15.4.2 Request messages**

The following messages are understood by the Slave:

RUN x
-------

Starts a game on the Slave. The x identifies the number of the game that is to be started:

1: PONG	6: MS Pac-Man
2: Tetris	7: Space Invaders
3: Prince of Persia	8: Arkanoid
4: Pole Position	9: MS-DOS Shell (for debugging)
5: The Secret of Monkey Island	

If a game is already running at the time a new one is requested, the old game is first terminated before the new one is started.

#### KILL

Terminates the currently running game on the Slave. If no game is running at the moment, the command is ignored.

#### LIST

Outputs a human-readable list of available games and their associated number to be used with the RUN command. This command is intended only for debugging purposes and may be used when accessing the Slave using terminal client software.

### 15.4.3 Response messages

After receiving a RUN or KILL message from the Master, the Slave tries to perform the requested action and replies with one of the following:

#### OK

The operation succeeded (in case of a RUN request: the game was successfully started; in case of a KILL request: the game was either successfully terminated or no game was running at the time).

ERR
-----

The operation could not be performed. This situation may occur due to one of the following reasons:

- The command was not recognized (i.e. not a RUN or KILL or LIST request).
- The command was a RUN request and the parameter (number of the requested game) was missing or out of range.
- Some problem occurred while trying to start a game (for example, a required file was not found, or some other execution problem occurred). The game was not started.
- Some problem occurred while trying to terminate a game. The game was not terminated and is still running.

No further information is transmitted about the nature of the error, however, a detailed description is displayed in a logging window on the Slave computer.

#### 15.4.4 Notes

- Messages have to be terminated by either a Carriage Return character followed by a Line Feed character (ASCII 0x0D and 0x0A) or alternatively by a Line Feed character only (ASCII 0x0A). This facilitates debugging of the application using simple terminal client software.
- Messages are case-insensitive. The character encoding of the transmitted strings should not be an issue since only characters from the first 128 code points of the ASCII set are used, which are the same in all encodings that are in wide use today.
- Games running on the Slave are only stopped when either the RUN or KILL message is received. None of the available games can be terminated by a timeout on behalf of the Slave, or through direct user interaction (such as losing the game or by certain input combinations).

## 15.5 Games

### 15.5.1 Criteria for selection

The following criteria were formulated for selecting a few representative games for inclusion in the project.

- **Popularity:** Each selected game should have achieved a considerable level of popularity (both at its time of release and in a long-term context), so that at least a few of the games would be recognized by the average visitor of the museum.
- **Influence on further developments:** Each selected game should have in one way or the other influenced the future development of the game industry, be it through some unique new innovation or the overall quality of the game.
- **Ease of use:** The selected games should use a sufficiently simple way of interaction, so that visitors of the museum can start playing them in a relatively short amount of time.
- **Good overview:** The total collection of selected games should be as representative as possible and present a good overview over time, genres and platforms.

### 15.5.2 Final Selection

The following software was finally selected and included in the project Softwaremuseum.

PONG	1972, Atari
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Popularity: Very high (widely recognized and considered a classic of electronic games)

Ease of use: Very simple (moving a paddle)

Influence: Heavily influenced many of the earliest games



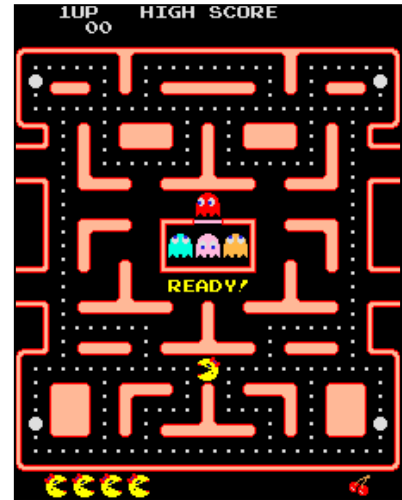
## MS Pac-Man

1981, Midway

Popularity: Very high (successor of *Pac-Man*, the best-selling arcade game ever)

Ease of use: Very simple (guiding Ms. Pac-Man through a maze)

Influence: Resulted in a wave of clones and is representational of the Golden Age of Arcade Games



## Tetris

1985, various

Popularity: Very high (considered to be the best known electronic game ever)

Ease of use: Simple (rotating and moving falling pieces)

Influence: Introduced logic and puzzle-solving into games.



## Space Invaders

1978, Taito

Popularity: Very high (has had a large impact on popular culture)

Ease of use: Simple (moving a spaceship and firing laser shots)

Influence: Sparked off the “Shoot ‘em Up” genre and introduced the idea of displaying high scores.



Prince of Persia

1989, Brøderbund

Popularity: High (very popular game on the IBM PC)

Ease of use: Medium (running, climbing, jumping, fighting)

Influence: Set standards in the Platform genre and is notable for excellent character animation.



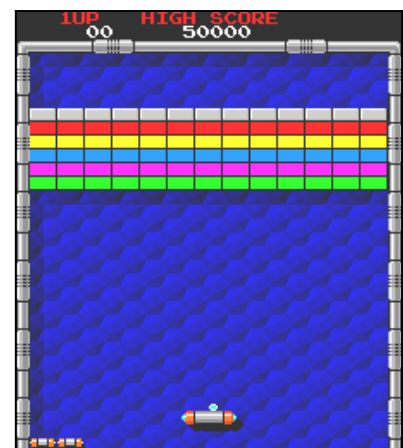
Arkanoid

1986, Taito

Popularity: High (very popular in the Golden Age of Arcade Games)

Ease of Use: Very simple (moving a paddle)

Influence: Combined several challenges into one game (hitting a ball, aiming, using power-ups, avoiding enemies)



Pole Position

1982, Namco

Popularity: High (innovative new kind of arcade game)

Ease of Use: Medium (steering a car, accelerating, braking)

Influence: Shaped the Racing game genre and introduced a new level of speed and suspense.



Popularity: High (popularized Adventure games on the IBM PC)

Ease of Use: Simple (point-and-click interface)

Influence: Introduced many new ideas into the Adventure genre.



## 15.6 Emulation Software

In order to be able to run games from various platforms on a single PC using Microsoft Windows 2000, a number of so-called emulation software is employed. Such software is specialized on simulating the environment of certain computer hardware and can therefore execute programs not native to the host platform. The following emulation software is installed on the Slave machine:

Platform	Emulation software
Arcade	MAME32 0.58 <sup>1</sup>
Macintosh	Basilisk II <sup>2</sup>
ZX81	X-Tender <sup>3</sup>
C64, Atari	MESS32 0.36 <sup>4</sup>
Game Boy	VisualBoyAdvance 0.9a <sup>5</sup>

## 15.7 Additional Work

During the specification and implementation phases of the Softwaremuseum project, several changes to the project goals were made, which resulted in some additional work that was not incorporated into the final implementation:

- It was considered to build a Y-connector cable for the gamepad so it could be attached to the gameports of both machines and used to control both the user interface on the Master

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<sup>1</sup> <http://mame32.classicgaming.gamespy.com/>

<sup>2</sup> <http://basilisk.cebix.net/>

<sup>3</sup> <http://www.delhez.demon.nl/>

<sup>4</sup> <http://www.mess.org/>

<sup>5</sup> <http://vba.ngemu.com/>

and the games on the Slave. This would have been possible to achieve with fairly reasonable effort due to the rather simple electric design of gameports and respective input devices, but it was decided that a trackball would be used instead as input device for the user interface.

- In a similar manner, it was considered to make mouse movements and clicks available to both machines, which could have been achieved by capturing mouse events on the Master machine and transmitting them via a UDP network protocol to the Slave machine, where they would have been induced to the operating system using the Windows API or a custom device driver. This idea was later dropped in favor of simplicity of the design, and because all finally selected games were able to use the Sidewinder gamepad instead.
- For some time a keyboard was considered as a possible input device, which would have required additional efforts for maintaining system stability and security (i.e. certain key combinations such as Ctrl+Alt+Del or Alt+Tab would have had to be blocked using a low-level keyboard filter driver or similar measures). A prototype version of such a driver was implemented for Microsoft Windows 2000 using the Windows Driver Development Kit.

## 15.8 Result

The implementation of the Softwaremuseum was successful and became an integral part of the “medien.welten” exhibition.



Picture 83: The Softwaremuseum installation at the “Technisches Museum” in Vienna

Some downsides of the installation can be described as follows:

- The Macromedia Director user interface can be difficult to understand when first trying out the installation. In order to start a game, up to 5 input steps with the trackball may be required. This can be explained by the complexity of the user interface, which – apart from starting games – involves tasks like browsing a timeline and viewing multimedia content.
- The Sidewinder gamepad is not optimal for all games, e.g. *Prince of Persia* involves many complex movements which can be hard to perform. However, the gamepad is sufficient to give visitors a good impression of the game, and – considering the variety of all games in the installation – it is still believed to be the best choice compared to alternatives.

In total, the Softwaremuseum has proven to be robust, attractive for visitors at all ages, and it effectively gives a good impression of the complex topic of electronic game history.

## 16 Conclusions

The aim of this thesis was to explore electronic game history and gain an understanding of the characteristics, milestones, social implications and driving forces behind this new medium. As a practical result of this work, the Softwaremuseum installation was designed and implemented.

It can be said that the first electronic games were invented almost immediately as soon as suitable hardware became available, and from the beginning on they exerted fascination and had a strong impact on society. This reflects the basic human need for playing, exploration, challenge and competition. In a way, electronic games can be viewed as a new way for satisfying this need, and they have proven to be very successful in doing so.

Yet, electronic games are today regarded as more than just a new form of entertainment. They are a medium that can tell stories, communicate ideas and arouse feelings in the one playing the game. In addition, games have an artistic aspect, which is one of the reasons why classic games enjoy new popularity today: Characters from early games such as *Pac-Man* or *Space Invaders* were so well-designed (considering the technical limitations) that they are still recognized by many people today.

Game history is characterized by extreme diversity and fast change. Even though hardware capabilities often imposed limits on what was possible, game designers were always able to overcome such limits and produced a large range of game types (genres), which differ from each other in their basic idea and in the skills required to play them.

One interesting aspect of electronic games that can be observed from the beginning up to this day is a mutual influence which games and other parts of popular culture have had on each other. Themes from movies, literature and music often find their way into games (one early example being *Donkey Kong*), and in return several highly successful games resulted in the creation of movies and/or books (e.g. *Tomb Raider*).

Today – as available hardware has dramatically improved – successful games require a good idea, well-implemented game play and sophisticated music and graphics. Another integral component of most modern games (with a few exceptions) is human interaction through multiplayer technology, which has revolutionized the way electronic games are understood. The resulting diversity and complexity have given rise to discussion and research on the inherent

properties of this new medium and on the topic of what it is that actually makes games fun to play. While some people favor games that are complex and as realistic as possible, others like simple games which are fast and easy to understand. This relation between audience and game genres, as well as social considerations in games, will certainly be among the focal points for future innovations.

In conclusion, we observe that electronic games are an exciting new medium marked by diversity and fast change, and driven by the ever-changing interest and curiosity of players. Due to the enormous processing power of today's computing hardware, possibilities for games are now greater than ever before, and it will be interesting to experience new electronic game innovations in the years to come.

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## 18 References

FORSTER, W. „Spielkonsolen und Heimcomputer – 256 Geräte von 1972-2002“, Gameplan-Verlag ([www.gameplan.de](http://www.gameplan.de)), ISBN 3-00-010658-8

KENT, S. „The Ultimate History of Video Games“, Prima Publishing, ISBN 0-7615-3643-4

LISCHKA, K. „Spielplatz Computer – Kultur, Geschichte und Ästhetik des Computerspiels“, Heise-Verlag, ISBN 3-88229-193-1

BURNHAM, V. „Supercade“, MIT Press, ISBN 0-2625-2420-1

DEMARIA, R. / WILSON, J. L. „High Score!“ second edition, McGraw-Hill / Osborne Media, ISBN 0-0722-3172-6

MERTENS, M. / MEISSNER, T. „Wir waren Space Invaders“, Eichborn-Verlag, ISBN 3-8218-3920-1

HUIZINGA, J. „Homo Ludens – Vom Ursprung der Kultur im Spiel“, rororo-Verlag, ISBN 3-499-55435-6

Wikipedia – <http://en.wikipedia.org>

The Killer List of Video Games – <http://www.klov.com>

PONG Story – <http://www.pong-story.com>