Evolution of Arcade Games: Though Improvements Were Being Made, Technological Constraints Built a Base of Creativity

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Date Dec 5th 2025

Abstract

Games have always been an option for socialising, and people entertain themselves by playing all kinds of games, such as arcade games, shooter games, role-playing games, and even board games. In this paper, we will dive into the evolution of game design from the 1960s all the way to the modern 2010s. We will be looking at arcade games, particularly, and examining how games changed mechanically, stylistically, and interactively under the influence of technological factors. The evolution of arcade games reveals that technological limitations and technological advancements both played a role in shaping the growth of the industry itself, when the influence of constraints is often overlooked.

Early Stages

When computers were less developed back in the day, it led to high prices and low prevalence of them. The limitation with accessing computers then led to the domino effect of new innovations and significances. *Computer Space* was one of them, a product fueled by limitation. During the 1970s, the video game industry was nonexistent, and arcade games were in their infancy (The Strong National Museum of Play, 2023). Computers and technologies were in their early stages of development, and video games that many people play on a daily basis today were something that only existed in universities and research labs. Before the hardware of an arcade, its earliest form of this kind of machine was called Computer Space. Unlike the modern arcade machine, *Computer Space* was designed to run one single game while avoiding the cost of buying a gaming computer. A computer that could run games at the time cost more than 100,000 dollars, which was extremely expensive. Although *Computer Space* did not enjoy significant commercial success and was full of flaws, such as counterintuitive physics, the game was released in 1971 and arguably started the era of coin-operated arcade games and led to the creation of many other

coin-operated video games, such as *Demolition Derby* (1972), *Home Pong* (1975), and *Asteroids* (1978). In addition, Bushnell established the principle in game creation known as Bushnell's Law: the game should be designed as quick to learn and understand by new players, while offering challenges and complexities to keep the older players engaged. This is a fundamental principle of game design that still applies today.

The Golden Age of Arcade Games (Late 1970s – Mid-1980s)

The release of *Computer Space* was groundbreaking; however, one of its biggest issues was gravity. The game was about a rocket to shoot spaceships. And it was a big issue that caused the former Atari employee Jerry Jessop to say, "The game play was horrible", talking to The New York Times (Before the Big Bang; The Space Age Game That Set the Stage, 2001). The lack of gravity makes the objects move awkwardly and hard to control. The objects will drift in the direction last pushed. Movements like falling, settling, and slowing down that are often expected by the player would not happen on their own, resulting in the player being frustrated with controlling the rocket's movement when trying to shoot. *Computer Space* was made using television technology rather than computer technology; "This technology couldn't do the gravity calculations" (Before Pong, There Was Computer Space, 2021). The problem that *Computer Space* struggled with was eased when *Pong* (1972) was released by Atari, the company founded by Nolan Bushnell and Ted Dabney (Gravity in Computer Space, 2019). *Pong* was their second effort. Instead of trying to add a gravity calculator to the game experiences, Atari decided to focus on the simplicity of the gameplay. There is still some physics involved in the gameplay, such as collision, but the instructions, controls, and scenery were simple. The design of *Pong* was able to enhance users' experiences by avoiding too much physics and other technologically demanding mechanics that were too great to overcome at the time. Moreover, "... by switching

from a side view to a top-down view…", the falling of a ball needs less attention, making gravity a less prominent factor in gameplay (Gravity in Computer Space, 2019). As a result, *Pong* was a much more successful game than *Computer Space*. Despite leaving out the impact gravity can bring to a video game, *Pong* represents the success of an early arcade video game when television technology was limited. *Pong* is an example of a game which emphasises playability over game complexity. While advancements in technology are important to pushing the evolution of game design, adoption based on constraints arguably played a bigger role in the industry's advancement here.

Gun Fight (1975) was a leap in terms of advancing technology. It is the "first ever commercially available arcade game to use a microprocessor, Intel 8080", a technology that boosted the possibilities in arcade game development and later would be used in Space Invaders too (From Transistors to Microprocessors: This Classic Arcade Game Was the First and Last of a Generation, 2018). Before *Gun Fight*, "Pong used 66 integrated circuits", which was groundbreaking because it incorporated multiple circuits into one integrated circuit that has all the main computer functions in one (From Transistors to Microprocessors: This Classic Arcade Game Was the First and Last of a Generation, 2018). Unlike standard integrated circuits, a microprocessor is programmable and runs at a high clock speed, making redesigning more flexible and complex tasks achievable (From Transistors to Microprocessors: This Classic Arcade Game Was the First and Last of a Generation, 2018). The microprocessor allowed more physics to be added to arcade games, bringing "smoother animation and modular code reuse", making player movement more realistic and other physics-based gameplay applicable (The cultural macroevolution of arcade video games: innovation, collaboration, and collapse, 2025).

It seems they were able to fake physics in *Pong*, so one might wonder why physics like gravity is so important. In *Pong*, all the reflection angles are fixed based on the paddle, constant preset speed, and no acceleration. The whole gaming experience was pretty rigid and became less and less interesting as the ball movement became more and more predictable. Thus, the game experience was limited. When game physics is calculated and programmed rather than pre-setting it, there are greater variety of in-game interactions and possibilities within the environment, which are important to continuously keep the player engaged in the game. With the development of a microprocessor, the Intel 8080, *Gun Fight* is able to have more physics elements that avoid predictability and linearity. Physics can also bring more creativity from the player and encourage them to problem solve: "Providing the gamers with gameplay that relies on physics enables them to find their own solutions to complex problems"(Physics in Games: A New Gameplay Frontier, 2007). *Gun Fight* is a straightforward example of advancement in technology paving the way for evolution in games.

Six years later, in Japan, something that represents a huge leap in commercial games happened: *Space Invaders* (1978), a coin-based arcade game created by Tomohiro Nishikado. *Space Invaders* was a symbolic technological flaw that turned into a selling point. There are many reasons why *Space Invaders* is different from other arcade shooter games. One catchy function is the increasing pace of the game. "Bill Adams, director of game development for Midway Manufacturing Co., of Chicago, Ill., which licensed Space Invaders for sale in the United States, these features of the game were accidental. 'The hardware had a limitation—it could only move 24 objects efficiently. Once some of the invaders got shot, the hardware did not have as many

objects to move, and the remaining invaders sped up. And the designer happened to put out a sound whenever the invaders moved, so when they sped up, so did the tone'" (The Secrets Of Space Invaders, 2022). Although part of the success of *Space Invaders* needed some luck, it is still fair to say the game represents a symbol of the arcade golden age and commercial success. The game started in Japan and reached Europe and the United States, and became even more popular. Oftentimes, technological limitations frustrate game development, but this time, it sets up the success of the game. Instead of being a bug in the game, it creates a progressively harder and more engaging experience, which players love.

The Industry Crash and Decline of Arcades

In the 1980s, the arcade game industry reached its peak. Researchers agree that the decline was partially due to two reasons: the oversaturation of video games in general and the transition to home game consoles and PC games. Although we have seen multiple high-quality productions of arcade games widely popular at a global level, such as *Pong*, it resulted in a *Pong* clone crisis such that "Other developers, big and small, saw the runaway success of the game and brought out their own clones to take a slice of Pong's pie" (Atari Teenage Riot: The Inside Story Of Pong And The Video Game Industry's Big Bang, 2012). With less focus on delivering the game itself, quick money tends to be a high incentive for many creators, creating a crowded market with repetitive genre landscapes. The excessive amount of low-quality and clone games flowing into the market left little incentive for creators to create high-quality and original games. A good example of this phenomenon is the 1982 ET the Extraterrestrial by Atari for the 2600. One reason for this can be "The industry's rapid expansion led to a gold rush mentality. Publishers, desperate to cash in" (The Video Game Crash of the 1980s: Was E.T. the Extraterrestrial the

Catalyst or a Convenient Scapegoat?, 2025). The crisis was eased by Nintendo, but the saturation issue continues to be a problem that shapes today's game industry.

As more home game consoles emerged, like the Atari 2600 (1977), people didn't have to walk out of their house to go to a game centre to enjoy the same game. The increasing convenience made gaming in the format of an arcade less appealing. As we proceed into modern times, the invention of the Nintendo Entertainment System and the creation of console games like *Super Mario* (1985) introduced a new age in the game industry (The Rise, Fall, and Resurgence of the Arcade Game Industry, 2022). Although seeing a dim light, like *Street Fighter 2* (1991), consoles continue to dominate in the long run. As technology developed, there are way more variations of ways games can be formatted.

The rise of PC games further split the pie in the industry (The Rise, Fall, and Resurgence of the Arcade Game Industry, 2022). By the 1990s, PlayStation and Nintendo 64 were released in succession. In the 2000s, arcades fell significantly behind Xbox and PlayStation 2. Despite the continuous decline of revenue in arcade games, they remain a classic in their golden age. Modern-day people are still motivated to spend on arcade games as they bring back a sense of nostalgia. As AR and VR are incorporated into arcade games, it drastically improved the novelty in arcade games. A good example is *Mario Kart Arcade GP VR* (2017). As a result, "by 2022, revenues jumped to $12.37 billion" (The Rise, Fall, and Resurgence of the Arcade Game Industry, 2022).

Conclusion

It is straightforward to spot how microprocessors are able to advance game design through technological breakthroughs. Limitations such as gravity calculation and hardware also paved the way for new inspiration and transformation into ‘first of a kind’ ideas. Those limitations are an important part of the success of *Computer Space*, *Pong*, and *Space Invaders*. In summary, the Influence of constraints makes just as much of an impact on game evolution as technological advancement.

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