The sound of the early video game arcades is probably embedded in the consciousness of everyone who was a child during the late 1970s and early 1980s. To walk into an arcade was to experience an overwhelming onslaught of crashes, laser guns, synthesized speech, and electronic beeping music, all competing for our attention. There have been several attempts to recreate the video game arcade atmosphere (such as Andy Hofle’s Arcade Ambience Project\(^1\)), and the few existing soundscape recordings have been so popular that they were released on CDs.\(^2\) A website selling the CDs describes, “We will never hear such beautiful chaos quite the same way again.” On a Wired magazine blog entry about the site, a fan posted, “This is the greatest audio archive ever. I nominate that guy [who put together the collection] for the Nobel Prize.”\(^3\) Judging by the popularity of these arcade soundscape recordings, sound played a critical role in the enjoyment and success of early video games, and plays a powerful role in the nostalgia for the time.

It is difficult to completely separate the sound of the early electronic video game arcades from the arcade industry that existed prior to the development of digital (solid-state) games. It was the electromechanical and slot machine gambling industry that gave birth to video games as commercial products. Most of the companies entering the video game market in the late 1970s already had a strong footing in the pinball and novelty arcade machine industry, as well as in slot machines. Bally Manufacturing Company, for instance, began in the 1930s with Bagatelle, a French parlor game similar to bumper-billiards that they adapted and developed into the first
pinball machine. Midway Games, who worked closely with Taito to bring popular video games to the American market, was a subsidiary of Bally. Although Bally no longer creates video games (after selling the video game portion off to its rival, Williams), the company continues to create slot machines and electronic lottery machines. Williams Manufacturing had been around since the creation of 1934’s *Contact* game, perhaps the first pinball game to have sound, and entered the video game industry with a clone of *PONG* (1972) in 1973. Sega and Gottlieb likewise began as pinball and mechanical arcade companies and eventually entered the video game market.

Pinball and other electromechanical arcade games included sound in the machines very early on. At first, this was bells and buzzers; later, mechanical ball-bearing chimes created simple musical tones, such as those in 1976’s *Bally Freedom.* It was not until the late 1970s that pinball machines used electronic sound components. Some electromechanical arcade games (pinball, gambling race games, shooting games, etc.) had four-track and later eight-track tape player units incorporated into them to play music and sound effects. One archivist describes the tapes:

Some of the tapes are simply used for background music and/or sound effects. Others had audio tracks dedicated to particular game functions. For example, the *Wild Kingdom* tape just has the same jungle sound effects on every track. But the *Haunted House* gun game has four discrete audio tracks: one for the background and the other three for specific target sounds. Also, some Chicago Coin gun games offered an optional 8-track player but did not include a tape. They expected the operator to supply a pre-recorded 8-track with whatever music they wished. The flyer for Funland put it this way: “Musical background can be changed to fit the mood of its locale.”

Hybrid electromechanical/solid-state games also existed, combining eight-track tapes with analog or digital sound. For instance, in Atari’s *Triple Hunt* (1977),

the 8-track tape is used for background sound effects only. The game’s microprocessor generates all other game sounds. *Hit the Bear* and *Raccoon Hunt* use the same background sounds: 30 seconds of nighttime forest sounds—crickets, frogs and lots of background noise. *Witch Hunt*, on the other hand, was a much more elaborate production. [It is] 3 minutes and 26 seconds of spooky sound effects: wind, blood-curdling screams, creaking doors,
pounding heartbeats, wolves, and even some speech playing backwards. It’s no wonder most Triple Hunt games on location were set up for Witch Hunt.⁶

The early game companies—Bally, Williams, Gottlieb, Sega, Midway, and others—had well understood the importance of sound in attracting players to the machines and keeping them interested when they entered the video game market. The very first (un-marketed) video games had no sound, but the games that were commercially developed and marketed for the arcades included sound and marketed it as a key selling point.

This essay describes sound in video games up until 1983 and is divided into three parts: “How Sound Was Made” explains the technology that was being used to create sound effects and music in games in the early days; “How Sound Was Used” describes the ways in which sound was commonly employed in games; and “Key Influential Games for Sound up to 1983: A Series of Firsts” outlines some of the key sound innovations during the time period before the Great Video Game Industry Crash of 1983.

**How Sound Was Made**

Sound waves are described using three properties: wavelength, frequency, and amplitude.⁷ The wavelength is the distance from one peak of a wave to the next, or the distance between maximum compressions. Frequency, the technical name for pitch, is a measure of the number of pulses (waves) in a given length of time. It is measured in hertz (Hz) or cycles per second (CPS). For example, a wave with a frequency of 440 Hz (the musical note “A”), means that in one second, 440 pulses occur. Shorter wave lengths result in higher frequencies. Amplitude is the measure of the amount of energy in a wave (technically, the amount of compression the wave is under), typically described as intensity or loudness. The more energy a sound has, the more intense, or loud, the sound results.

Most sounds, in addition to their fundamental frequency, have extra harmonic frequencies that are a ratio of the fundamental frequency, which give the sound its character or timbre. Pulse waves contain only odd harmonics and are rectangular waveforms with “on” and “off” slopes, known as the duty cycle. When the duty cycle is of equal length in its on and off period, it is known as a square wave. Changing the duty cycle options (changing the ratio of the on to off) of the pulse wave alters the harmonics. At 50 percent (square wave), the waveform is quite smooth, but with adjustments, a pulse wave can be “fat,” or thin and “raspy”). Pulse waves are often
referred to as “hollow” sounding, or slightly “rough,” and were the most common sounds for video games of this early era.

Sound in video games before the mid-1980s commonly used one of two technologies: beepers or programmable sound generators. Although driven by digital technology, beepers were analog sound generators. Analog sound records and produces the electrical output of sound waves as they occur, whereas digital sound breaks the information down into a series of 1s and 0s (on and off) and stores that numerical information to later reproduce the sound. Although early games used analog circuitry, this sound was typically controlled and manipulated digitally, and was nearly always some form of pulse wave.

**Analog Sound: PC Speakers and Piezoelectric (Beeper) Audio**

Beepers are simple speakers, and in the early days were typically “on board,” meaning they were attached directly to the motherboard of a computer. Early video games and electronic toys sometimes used what is called a piezoelectric speaker—colloquially referred to as a beeper, since a “beep” was about all they could handle, and they were often found in simple appliances to use to make warning beeps. Piezoelectricity is the term used when mechanical stress is placed on a material—in this case, ceramic—generating electricity and mechanical resonance. Piezoelectric microphones are commonly used in pick-ups for guitars, and piezoelectric technology is used in a variety of speaker systems, such as portable radios and watches. Piezoelectric speakers have a limited frequency range and are typically used today in only very inexpensive devices, for example, a sonar or sensor. They are, however, cheap, small, and thin, so can be useful in a variety of toys and small electronic devices.

Sound is made on a piezoelectric speaker by the piezoelectric diaphragm, a small ceramic plate with electrodes on both sides, attached to a metal plate (see Fig. 8.1). A DC voltage is applied between the electrodes, causing a mechanical distortion that bends the diaphragm back and forth, causing a sound wave. Sound can therefore be generated by turning the piezoelectric speaker on and off in rapid succession, bending the diaphragm many times a second. A 2000Hz tone, for example, requires the speaker to be turned on and off 2000 times per second. For 11kHz tone, the wave would need to be toggled at 11000 times per second.

Early handheld video games commonly used piezoelectric technology. Mattel's LED-based *Auto Race*, which came out in 1976 and was the first all-electronic handheld video game, used a simple piezoelectric speaker. The game was programmed by Mark Lesser, who noted in an interview, “The sound was implemented using a single output and a piezo-ceramic
speaker—one output line to generate sounds and music, such as it was, without any sound driver hardware. The toggling of the speaker had to occur within the program loop, with variable timing to produce tones.”

Although Auto Race may have been the first, Football, released June 1977, was probably Mattel’s most popular seller. Right from these early days, sound was nearly always used as a selling point. A description in the 1978 Toy Fair catalog advertised, “Cut back, avoid tacklers, run for daylight! Score and hear the Victory Sound!” Mattel’s Football II, released the following year, boasted: “Simulated game sounds include whistle and the victory tune for those hard-fought touchdowns and field goals.” Although these early Mattel LED games primarily had just simple sound effects, at least one had music: Missile Attack (1976, later released as Battlestar Galactica Space Alert) played “Taps” when the player lost.

Home computer internal speakers were also referred to as beepers, since they, too, often emitted no more than a simple beep. At best, a home computer speaker was a simple one-channel, square wave tone that could play at different frequencies through its 2-inch speaker cone. These were electromagnetic speakers, in which two magnets create a repulsion and attraction, pushing and pulling the speaker cone in a similar fashion to a piezoelectric speaker’s diaphragm, with the frequency and amplitude of the input wave dictating the rate and distance that the speaker voice coil moves. The speakers would commonly have just two levels of output: they were, in other words, 1-bit sound.

This 1-bit sound could be improved slightly by using what is known as pulse width modulation by controlling the analog circuit with the digital computer timer. In other words, it was possible to digitally encode the analog sound through the use of high-resolution counters. Since the speaker
could produce two sound levels (on and off—the cycle of on to off representing the frequency of the pulse wave), it was possible to carefully time the pulses of sound waves so that the speaker left in the “off” position for a fraction of a millisecond emitted sounds in between the on and off levels, thereby increasing the possible frequencies.

In the analog days of electromagnetic and piezoelectric sound technology, the sounds that were available were dependent on the hardware circuitry. The PONG sound—like many early games successes—was a bit of an accident, as creator Al Alcorn recalls:

The truth is, I was running out of parts on the board. Nolan [Bushnell, Atari’s founder] wanted the roar of a crowd of thousands—the approving roar of cheering people when you made a point. Ted Dabney told me to make a boo and a hiss when you lost a point, because for every winner there’s a loser. I said “Screw it, I don’t know how to make any one of those sounds. I don’t have enough parts anyhow.” Since I had the wire wrapped on the scope, I poked around the sync generator to find an appropriate frequency or a tone. So those sounds were done in half a day. They were the sounds that were already in the machine.\(^{12}\)

A 1976 game machine programming guide described how audio was driven by the hardware and vice versa: “Sound circuits are one of several areas which show little specific similarity from game to game. This is a natural result of designers needing very different noises for play functions of games where the theme of the machines varies greatly. For example, a shooting game requires a much different sound circuit design than a driving game.”\(^{13}\) This hardware specificity changed somewhat with the development of dedicated sound chips, or programmable sound generators.

**Programmable Sound Generators**

Programmable sound generators (PSGs) are sound chips designed for audio applications that generate sound based on the user’s input. These specifications are typically coded in assembly language to engage the oscillators. An oscillator is an electrical signal that generates a wave form, and sine waves are the most common form of oscillator. An oscillator is capable of either making an independent tone by itself, or of being coupled cooperatively with its neighbor in a pairing known as a tone generator. The tone generators produce the tones, typically as a square wave. In the late 1970s and early 1980s, PSGs generally had three separate tone generators (see Fig. 8.2). There was also typically a noise generator, usually a pseudo-random
pulse-width square wave output. Mixers combined the tone and noise generators. Amplitude controls gave the digital-to-analog converter a fixed or variable amplitude pattern. An envelope generator produced an envelope pattern to shape the sound. Instrument sounds are typically created with both a waveform (tone generator) and envelope generator.

Various effects, such as vibrato (frequency modulation) and tremolo (volume modulation) could be simulated or created using different techniques. Frequency sweeps could be used for lasers, whistling bombs, race cars, and so on. Doppler and noise sweep effects were useful for racing games, and the noise channel could be used for gunshots, explosions, and other sound effects.

The programmable sound generator chips, however, were primitive by today’s standards, and the accuracy of frequencies varied, meaning they were commonly slightly out of pitch. The 1979 General Instruments (GI) manual for the AY-8910/8912 series, for instance, explained: “The nature of the PSG divider scheme produces a high degree of accuracy for low frequencies, less for high frequencies.” They even go so far as to provide a chart of ideal frequency and actual frequencies. The AY-8910 (and derivati...
tives) found its way into a variety of home computers and games consoles including the Sinclair ZX Spectrum, Amstrad CPC, Mattel Intellivision, Atari ST, and Sega Master System. Many video game PSGs were created by GI or Texas Instruments, but some companies, such as Atari and Commodore, designed their own sound chips in an effort to improve sound quality.\textsuperscript{15}

\textit{Programming Sound}

Sound had to be created by the game’s programmer, a very time-consuming process. Early games were typically programmed in assembly language. A simple beep, for instance, would take nearly 20 lines of code.\textsuperscript{16} An understanding of programming was essential for any game audio personnel, however, since software sequencers and MIDI did not yet exist for composers. According to Hitoshi Sakamoto, “The priority for Japan[ese] game companies was to hire people based around this level of computer literacy, as opposed to their composition skills . . . The process of composing was 10 percent notes, and 90 percent programming those notes.”\textsuperscript{17} Mark Turmell, a game designer for Sirius and later Fox Video Games and Activision, creator of \textit{Fast Eddie} (1983), \textit{Turmoil} (1984), and others, explained that sounds involved a lot of testing: “It’s an intricate process . . . Sounds are made up of numbers in a computer. It often starts on a random basis.”\textsuperscript{18} Nintendo composer Hirokazu “Hip” Tanaka elaborates: “Most music and sound in the arcade era (\textit{Donkey Kong} and \textit{Mario Brothers}) was designed little by little, by combining transistors, condensers, and resistance. And sometimes, music and sound were even created directly into the CPU port by writing 1s and 0s, and outputting the wave that becomes sound at the end. In the era when ROM capacities were only 1K or 2K, you had to create all the tools by yourself. The switches that manifest addresses and data were placed side by side, so you have to write something like ‘1, 0, 0, 0, 1’ literally by hand”\textsuperscript{19} Rob Hubbard, a well-known composer of Commodore 64 games, noted, “Basically you had to learn assembly language programming to get anything done on these machines . . . very, very low-level assembly programming to get it all to work. There were no high-level tools or methods of being able to get the music in.”\textsuperscript{20}

The fact that composers had to be programmers often meant that the music—typically just theme songs—was created by programmers with little or no training in music. In some cases, songs were translated from sheet music into code, often with errors.\textsuperscript{21} Rob Hubbard describes his entry into the industry: “The games that were around in like, 1982, 1983, most of the music was done by the programmer. The programmer did everything in those days, and some of the music was just absolutely diabolical. I mean,
it was embarrassing, you know. It was like a drunken monkey . . . on the piano, trying to play the Blue Danube or something . . . and I thought, there has to be an opening for somebody that can at least get the notes right . . . in the correct order, for God’s sake.”

**How Sound Was Used**

*Coping with Constraints*

The difficulties involved in the available technology were numerous. Not only did composers or sound designers have to be programmers, but the computer and sound hardware had many limitations. In most early games, there was no background music, simply because the processors could not simultaneously process sound, graphics, and interaction. At best, then, games would have short theme songs that played at the beginning, in cut-scenes (short, non-interactive sequences between levels), or in attract mode (see later discussion).

Memory was a significant problem, noted Garry Kitchen, a developer for a variety of systems: “You put sound in and take it out as you design your game. You have to consider that the sound must fit into the memory that’s available. It’s a delicate balance between making things good and making them fit.”

Another significant problem was porting (translating) between games systems—an arcade game, a home console, or a home computer, for example, had different sonic requirements, and each system had unique sets of limitations. Ben Daglish, a popular composer of Commodore 64 music, described the process: “For me there was always a Platonic ideal. I’d have a ‘perfect’ version of a tune in my head that involved ‘real’ instruments, and then it was a case of arranging it for 3 voices, or even a 1-voice beeper (this was horrible, really horrible) . . . One would start with the SID version [the Commodore 64 audio hardware] then have to ‘downgrade’ to the others.”

Similarly, composer Chris Hülsbeck commented, “You always work[ed] with what you had and you always wish[ed] you had more, but it can be very satisfying to make a great piece of music within those limitations. The Commodore C64 computer was the first generation that could do more than just simple bleeps and that’s why it attracted such a following among computer music enthusiasts . . . The most important difference was not the format how the music was sequenced, since that stayed fairly similar, but the difference in the sound chip.”

Although composing music for the systems was difficult, some programmer-composers enjoyed the challenge and believe it helped creativity. As Hitoshi Sakamoto says, “The process was inefficient. This can be seen
as an advantage, because despite technological limits, composers then had to focus on the essence of music-making. Each individual note and choice of sound effects was carefully examined for its effectiveness. Composers today should still maintain this approach of questioning each note for its usefulness . . . If you were a composer, you had to convince your audience it was not noise.”

Sound as Information

Recent research into video games has often made comparisons between games and films. Certainly there are many points of comparison between the functions of sound in film and recent games. However, today’s console games make use of 3-D sound to help orient the player and to indicate off-screen (acousmatic) events, draw us in emotionally, and create a sense of place in space and time. In the early days, sound had much simpler functions. There was very little attention paid to the rich role that sound can play in helping to create a scene, set a mood, and so on. This is not to say that emotion played no role—the simple four-note marching feet of Space Invaders (1978) would have undoubtedly influenced the engaged player as the aliens sped up to kill off the player’s character. Likewise, sound was used to emotionally draw the player into the game, or at least toward the game.

A primary focus of sound in arcade consoles was the “attract mode” function. Games in the arcades competed for the attention (and money) of players, and sound was an important way to draw attention, differentiate the machines, and remind players of previous enjoyment. This function perhaps grew in part from the years of experience many of the early video game companies had in the pinball and slot machine industries. Flyers for the games highlighted the importance of the attract function: “Super crowd-attracting race car sound effects” promises the flyer for Atari’s Gran Trak 10 (1974), and Meadows’s Lazer Command (1976) advertises “The ‘never before heard’ sound effects attract attention to the game when not in play.” Kee Games’s Tank! (1974) goes so far as to use onomatopoeia in its flyer: “Suddenly, the crunching, clanking sound of another tank tread is heard. A shell bursts near your tank! . . . Your shell “WHIRRS,” and then . . . the ground shakes as it explodes.” Clearly, since the promotional purpose of flyers is to convince store owners to purchase the machines, sound was an important purchase driver for the arcades. Simple sound effects were used to draw players—as in the pinball game Locomotion (1982), which whistled like a train, and Gottlieb’s Reactor (1982) with a short, repeated guitar riff. More advanced, digitally sampled or synthesized speech was used to taunt players and entice them to play. Sega’s Space Fury (1981), for instance, had an alien figure call out “Is there no warrior mightier than I?”

Karen Collins
and “Does anyone dare challenge my imperial fleet?”; Stern’s *Berzerk* (1980) would say, “Coins detected in pocket.”

When examining the early days of game sound, it may be more useful to put film theory aside and draw on research into interface design and auditory displays. In these sub-disciplines of computer science and design, sound plays an information-based role (although aesthetics comes into play in the perception of usability of the sounds). It is this information-based interaction with the sound that is at the heart of early game audio. In other words, sound in early games can be more ideally viewed as information and feedback-based.

Most sound in early games was feedback based on the player’s actions: the player was injured or died, was under attack, had taken an action (fired a gun, jumped, bumped into a wall), had earned points, or was experiencing a change in game-state (for instance, a new level begun). As previously discussed, sound in early computing was designed for error beeps and prompts, and the combination of technological constraints and computing history probably contributed to sound’s use as simple feedback device in early games. For example, the *Consumer Reports* November 1980 report on games describes the use of sound as a feedback device in the description of Vanity Fair’s *Computer Matician 3010* tabletop model: “The correct answer elicits a high-pitched, repeating beep and the word ‘right’ flashing at the top of the screen. An incorrect answer is punished by a penetrating low buzz and the word ‘wrong’ flashing at the bottom of the screen . . . most of the children were unnerved and annoyed by the strident beeping and buzzing.”

The other form of audio feedback or prompt was, of course, an alert to the player that they should take an action—that their spaceship was under attack, that an encounter with an enemy was imminent, that time was running out, and so on. In these cases, the game is expecting some form of response from the player. Turning the sound off, therefore, would be detrimental to gameplay, highlighting the importance of sound to games. The July 1983 issue of *Electronic Games* magazine tells the player of the Entex AdventureVision’s *Super Cobra* (1982), “Super Cobra makes use of a range of sound effects to enhance the play. Listen to these special tones since they frequently warn you of what type of enemy the helicopter will face next.”

For AdventureVision’s *Space Force* (1982), the same guide notes: “Pay close attention to the sound effects. The approach of alien ships are [sic] signaled by alien cannon fire. This alerts you to be prepared to shoot. Since the small spacecraft is worth 1000 points, you don’t want to let it slip past you.”

These information-based uses of sound (alerts, prompts, and feedback) were the primary functions of sound in video games in the early days, and
it was not until more advanced sound chips became available that polyphonic music became commonplace.

**Key Influential Games for Sound up to 1983: A Series of Firsts**

Although there were many games that were influential to the development of sound for video games, there were a few key influential games that are worth discussing for their innovations in the area of sound:

1971: *Computer Space*, designed by Nolan Bushnell and Ted Dabney at Nutting Associates. *Computer Space* was the first mass-produced arcade game, and had simple beeps and crashes. A flyer advertising the machine highlights its sound-based interactions with the user: “The thrust motors from your rocket ship, the rocket turning signals, the firing of your missiles and explosions fill the air with the sights and sounds of combat as you battle against the saucers for the highest score.”

1972: *PONG*, designed by Nolan Bushnell (adapted from a game by Ralph Baer). Based on the original game developed by Ralph Baer, Nolan Bushnell (who had created *Computer Space*) formed Atari Inc. and released *PONG*. Once again, sound is highlighted in the original flyer: “Realistic Sounds of Ball Bouncing, Striking Paddle.” Of course, the sounds were far from realistic, and have gone down in history for their simple sine-wave bloops.

1974: *Touch Me* from Atari. Taking advantage of the simple sound capabilities of early handhelds, Atari was one of the first to release an electronic musical-memory game. *Touch Me* was released as a coin-operated arcade machine in 1974 and as a handheld in 1978. *Touch Me*’s original 1974 flyer discussed the use of sound: “‘Beep’ or ‘Bleep’? *Touch Me* challenges the player to remember the sequence of sight and sound, and correctly repeat the pattern . . . When the sound occurs, the corresponding button lights to give a visual clue . . . Did you correctly repeat those sounds when the button lit?” There were four buttons and four tones on the machine whose patterns would get progressively more difficult. Ralph Baer, who would later redesign the game as *Simon*, recalled, “I was in Chicago attending an MOA (Music Operators of America) show of coin-op devices. I went to these shows routinely on Sanders’s and Magnavox’ behalf to check on the presence of games that might infringe our patents, for which Magnavox was our primary licensee. Atari had several coin-op units at the show. One of these was “Touch Me” . . . Howard Morrison also saw “Touch Me” and played it . . . Some time later, we discussed the game. We both came to the
same conclusion: Nice game idea, terrible execution... visually lousy, miserable sounds!\textsuperscript{38}

1976: \textit{Missile Attack} was perhaps the first electronic handheld LED game with music (although not the first with sound generally): it played “Taps” when the player lost.

1977: Atari’s earlier \textit{Touch Me} did not catch on until it was redesigned by Baer for Milton Bradley and released as \textit{Simon} in 1977. Similar to \textit{Touch Me}, each button on \textit{Simon} had a corresponding sound and color, and increasingly difficult melodies had to be memorized. This time, Baer improved on the sounds, as he describes his selection: “I took on the job of selecting the four tones, which was a non-trivial matter because the tones actually define much of \textit{Simon}’s character. Looking through my kid’s Compton Encyclopedia for an instrument that can play a variety of tunes with only four notes, I found what I was looking for: The bugle! Henceforth, \textit{Simon} was programmed to beep G, C, E, and G... the bugle sounds that can be played in any sequence and still sound pleasant!”\textsuperscript{39} Also in 1977, Project Support Engineering’s game \textit{Bazooka} was possibly the first arcade game to offer stereo sound effects, and Exidy’s \textit{Circus} was possibly the first arcade game to have music, although as shown earlier, digital handheld games had music by this time. The music would play when the player got a bonus (stopping the action to play the music). When the player died, a brief funeral march was played.

1978: \textit{Space Invaders}, designed by Tomohiro Mishikado and released by Taito/Midway, was possibly the first game to have on-going background music/sound effects, the four-note marching feet of the aliens.

1979 (Japanese release) / 1980 (North American release): \textit{Pac-Man} (Taito/Midway). The continuing prominence of one particular game sound, Pac-Man’s “waca waca” (in English, the sound the character makes when eating, which was allegedly referred to as “Pakku-Pakku” in Japan, leading to the name of the game\textsuperscript{40}), is clear evidence of the significance of this influence. In the 1980s, the sound was incorporated into popular songs such as Buckner and Garcia’s \textit{Pac-Man Fever} (1982) and “Weird Al” Yankovic’s \textit{Pacman} (1983). More recently, it has been used by the bands Aphex Twin, Bloodhound Gang, DMX, Lil’ Flip, and many more. \textit{Pac-Man} was possibly the first game to feature full cut-scene music, although, as noted, \textit{Circus} had a short bonus music clip.

1980: \textit{Berzerk} and \textit{Stratovox} were the first arcade games to employ speech synthesis, although Williams had used speech in their pinball machine \textit{Gorgar} a year earlier. Tony Miller, chief engineer at Stern Electronics described: “The Williams pin \textit{Gorgar} was out when we were working on \textit{Berzerk}, and we thought it would be good to add voice. But \textit{Gorgar} used a
better synthesis system than ours. The robots seemed to go well with the cheap version of synthesis we used." Berzerk had a few simple phrases, such as “Help Me! Help Me!,” “Very Good,” and “Lucky.” Stratovox, released by Taito, likewise used voice the same year. The games used a Texas Instruments SN76477, a 1.5MHz chip that drained memory on the computers, causing the sound to be highly distorted.

1981: Nintendo’s Donkey Kong. A well-known bass-line created by Nintendo master game designer Shigeru Miyamoto and borrowed from John Lennon’s “Ballad of John and Yoko,” permeates the gameplay. The same year, Frogger introduced us to on-going dynamic background music. The game, in which the player guides a frog past cars and over moving logs into a series of four safe-houses, used at least eleven different gameplay songs, in addition to “game over” and level start themes. The player began in the main gameplay theme; when he or she successfully guided a frog into a safe house, the song would switch to another quite abruptly, continuing until a new frog either was successfully guided into another safe house (new song) or died (gameplay song).

1982: Journey Escape was released for arcade and a port by Data Age for the Atari 2600. This was the first game to feature a popular music artist, the band Journey, and probably the first arcade game to use cassette bonus tracks. Engineered by the band’s manager, Herbie Herbert, the game contained just the song Don’t Stop Believin’ (1981) when it was originally released for the Atari VCS home console in 1982. Recently, vocalist Steve Perry admitted he was against the game, “Cause I thought it was silly. I’ve come to find out that there’s a generation of kids who think it’s classic and wish they could find the arcade version. But I personally thought it was dumb . . . Because I thought that we were big already, that we didn’t need a video game.”

The same year, another popular music cross occurred: Data Age gave away free records to customers in September 1982. The 3.5-minute stereo discs were given to retail customers to promote the Data Age product line, which included Sssnake (1982), Warplock (1982), Airlock (1982), Bugs (1982), and Encounter at L-5 (1982). The record, called Mindscape, included sounds from the game, produced by Craig Hundley, creator of special electronic music for films such as The Black Hole (1979), Star Trek: The Motion Picture (1980), Firefox (1982), and others.

Also in 1982, Q*bert, although not the first, was perhaps the video game character most well-known for his speech (and perhaps the first video game character to swear). The arcade game also used a knocking sound in the cabinet that would bang when the character fell off the pyramid, as creator Warren Davis described:
One other thing should be credited and that is the knocker which would bang the cabinet after Q*bert disappeared from the bottom of the screen after a plunge. This was the idea of Rick Tighe, one of our technicians. He put a standard pinball coil in a test cabinet so that I could trigger it at the appropriate time. I didn't actually like the knocking quality of the sound. I wanted more of a thud, so it would sound like a sack of potatoes [sic] being dropped. With a little experimentation, we found that a small piece of foam glued to the right spot produced what I thought was the perfect thud. Unfortunately, the gluing of the small piece of foam was deemed too labor intensive for production and wasn't done. But the effect was still fantastic. The knocker was controlled by a DIP switch, so an arcade operator could turn it on and off.

The speech and sound effects were created by David Thiel, according to Davis: “Dave created all the sounds, many on his own, some in response to my suggestions. Dave was the one who came up with the idea of using the random phonemes of a speech chip to make Q*bert speak gibberish. Contrary to modern myth, he is speaking only gibberish. Nothing was ever programmed to be said specifically, with the exception of “Hello, I’m turned on” when you power the game up and “Bye-bye” at the end of a game.” Thiel, who programmed Q*bert’s “voice” using the Votrax speech chip, elaborated:

In the late 1970s, pinball designers were the human interaction researchers of the day. It was their desire to do more with interactive sound that led them to use synthesis rather than prerecorded audio . . . When I began working at Gottlieb, I tried to use subtractive synthesis where I started with a sound and then sculpted it with filters. I knew that many desirable effects could be created with just a noise generator and a versatile filter whose properties could be changed over time. Unfortunately, the minimal system synthesizer did not have enough horsepower. I built some filters that worked, but I could only change their properties as a power of two and the results did not have enough gain or variability to be of any use . . . Because I was developing these sounds in a commercial environment, I was under pressure from management to build a library of sounds that could be reused to speed up development. I resisted this approach because I wanted each game to have the best and most appropriate sounds. However, I needed to find ways to somehow speed up development to keep management happy.
while still being able to create cool stuff. This led me to create a synthesis algorithm that I called Multi. By setting eight parameters for the Multi synthesis algorithm, I created many distinctive, evocative, and dynamic sounds. The Multi synthesizer provides pulse width, volume, and pitch control over time in eccentric, but useful, ways.46

**Conclusion**

The early years of video games represented a time of rapid development underscored by technological constraints. Developing from the electromechanical pinball and arcade market, early video game sound served first and foremost to attract the player to the machine and to generate excitement in the arcade environment. This function grew from the fact that most of the video game companies of the time had had several decades of experience in selling other coin-operated games for the arcade market and had learned early on the importance of sound.

Due to technological advances, video games now are aesthetically very different from those of the late 1970s and early 1980s, but the key ideas about the roles of sound that were developed during this time still resonate with sound designers today. Although the functions of sound has broadened in today’s games, the early era of video games laid the groundwork for the interactive role that sound would play in the form of alerts, prompts, and feedback to the player. Sound was an integral part of gameplay, turning sound off would affect the ability to play the game. Even though the sounds themselves—relatively simple pulse wave tones programmed by hand—were quite simple sounding and low fidelity, they still often define “video game sound” for many, an indicator of their ubiquity and importance during the early days of video games.

**Notes**

www.youtube.com/watch?v=nyLFkW5IUew. Video.


7. The fourth property, velocity, is typically the same for all sound waveforms and so is not discussed here. Elements of this section are drawn from Karen Collins, *Game Sound: An Introduction to the History, Theory and Practice of Video Game Music and Sound Design* (Cambridge, MA: The MIT Press, 2008), 15–18.

8. It is this distinction, and the tiny fluctuations in signal that a digital sampling of an analog sound may miss, that makes some audiophiles prefer (analog) vinyl over (digital) CDs or MP3s.


16. The Atari Archives website has a great collection of early programming books in BASIC and Assembly that have been digitized. See Atariarchives.org, accessed July 11, 2009, http://www.atariarchives.org/.


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23. Martin, “Sound in Video Games: How Do They Make It? How Do We Use It?,” Video Games Player, 1983.


25. Ibid., 12.


35. Ibid., 118.


39. Ibid.

40. See “A Brief History of Pac-Man: A Timeless Classic,” accessed July 11, 2009,


45. Ibid.