

Limitations in Early Video Game Music and Their Aesthetic Impact

View the audio examples given throughout this paper in this accompanying Youtube Playlist: <https://bit.ly/2IzqdmX>

Think back to the first time you picked up a video game controller. You may remember the graphics or art style of that game, a favorite character, or that one level that you were stuck on for hours on end. Along with these memories, it's quite likely that you thought of the infectious melodies that accompanied your virtual adventures. Undoubtedly, video game music is one of the most memorable and essential parts of this medium that we hold so dear. It is important to note, however, that many of these soundtracks which we recall so fondly were made in the presence of technological challenges. The composers of video game music for the home consoles of the late 1980s and 90s overcame the limitations of these early systems by viewing what on the surface appeared to be constraints as challenges that would guide and enhance their creativity rather than control and restrict it. The choices made to combat or circumvent these technological limitations took place primarily in the areas of organization and timbre. It is in these areas that the limitations faced by early video game music composers have had a lasting influence on the aesthetic choices of contemporary video game composers, and as a result — the modern landscape of video game music.

Before we can properly identify how technological limitations have influenced the development of video game music, it is necessary to establish the context in which these limitations were faced. When arcade games were the primary form that video games took, music held a simpler function (and a much lower perceived importance). As Andrew Schartmann states in his book, *Koji Kondo's Super Mario Bros. Soundtrack*,

“Sound functioned primarily to attract the attention of customers and to provide background filler for gameplay” (30). This is not to say that the music of arcade games was completely devoid of innovation or creativity. Games like *Space Invaders* (1978) by developer/publisher Taito have soundtracks that, while primitive, serve an important role — to create tension. Indeed, Taito’s import manager S. Ikawa expressed that he believes this “feeling of tension” is created primarily by the game’s simple, yet effective soundtrack (Schartmann 32). While the soundtrack is essentially a very crude four-note loop that speeds up over time, its music had a greater effect than many of its competitors at the time, hence Taito’s assertion of how it was integral to the success of the game.

At this point, it is necessary that I address why many of the examples given in this paper are from NES (Nintendo Entertainment System) and SNES (Super Nintendo Entertainment System) soundtracks. First, as the most popular home consoles during their respective eras, these systems had perhaps the largest influence on the history of video games and in turn their music (Cunningham). This impact is magnified when you consider that these eras were unquestionably the times when home video games were growing at the most rapid rate. A burgeoning home console industry during the 1980s in America began a transition away from arcades, only to see the industry fully collapse following the 1983 implosion of the leading company at the time, Atari, and their Atari 2600 console (Rossen).

Indeed, “[i]t’s often said that video games might have died forever with Atari, remembered only as a short-lived fad, if Nintendo hadn’t come to the United States to

rescue them two years later” (Trautman). Nintendo saved the video game industry in America with the NES, and their SNES would dominate the market, albeit in a slightly less commanding way (Arsenault). These two consoles were the most technologically advanced of their time, especially sonically (Plafke). Therefore, by viewing these systems, it allows for an understanding of how the least limiting technologies were still extremely restrictive compositionally. Additionally, it was via the soundtracks written for these systems that the most creative and indispensable innovations would be made by composers. Therefore, the focus on NES and SNES soundtracks should not be seen as a limitation of scope, because these examples are heralded as some of the most influential soundtracks of all time.

Speaking of influential soundtracks, even those that are largely unfamiliar with video games and/or their music can most likely hum Koji Kondo’s “Overworld Theme” to Shigeru Miyamoto and Takashi Tezuka’s masterpiece, *Super Mario Bros.* (1985). Kondo’s first soundtrack that accompanies the iconic mustachioed plumber is simply unrivaled in terms of the influence that it has had on video game music. Kondo’s score was a clear departure from the soundtracks present in arcades at the time in the way that it revolutionized the purpose of video game music. This is primarily present through his organizational and compositional choices.

When Kondo was composing the soundtrack for *Super Mario Bros.*, the game was already fairly far along in development (“Miyamoto on World 1-1”). As such, he was able to play the game and get a feel for the platformer’s natural rhythm and Mario’s movement. Kondo has stated countless times that “the music is inspired by the game

controls, and its purpose is to heighten the feeling of how the game controls” (Schartmann 33). In this way, Kondo was interested in using his soundtrack to make the fictional world of the Mushroom Kingdom more immersive in order to bridge the gap between the player and their TV screen. While this point that a video game soundtrack wanted to make its world seem more immersive may seem trivial today, Kondo’s score for *Super Mario Bros.* was the first to truly accomplish this. Indeed, Neil Lerner and other researchers of video game music recognize that *Donkey Kong* (1981) and *Super Mario Bros.* are justly praised for “pioneering innovations of the genre of the platform game, but their music also deserves attention” (Donnelly). The bouncy, syncopated music of his “Overworld Theme” seems to eerily mirror Mario’s movements, and the sound effects contribute to accomplishing a similar effect. For example, the mickey mousing (when the music provides a synchronized, aural imitation of what is happening on the screen — see Disney’s “The Skeleton Dance” (1929)) present with the glissando that accompanies Mario’s physically questionable leaps not only serves to immerse the player, but also seems to live within Kondo’s musical score, further creating a single, convincing world for the player to stomp on Goombas, kick Koopa shells, and consume a copious amount of mushrooms (Whalen).

Kondo’s organizational choices and relative simplicity of his score are reflective of the technology that he was operating within. What makes this soundtrack so superior to many others of the late 80s (and even some of its contemporaries) is that it never feels constrained by these limitations. Instead, Kondo made these limitations work for him. Schartmann states the following regarding why Kondo considers some of his first

compositions, such as those for the *Super Mario Bros.* and *Legend of the Zelda* franchises, to be his greatest works:

Despite appreciating the variety of sounds now available to him, Kondo views technological advance as a double-edged sword: “[P]eople sometimes think, ‘well, we’ve got all of this.’ So rather than having to create something that’s really great, they ... rely heavily on technology, or say, the instrumentation.” In many ways, the stringent limitations of the 8- and 16-bit systems (i.e., the NES and SNES) fostered innovation to a degree unrivaled by modern consoles (29).

Indeed, Kondo viewed the limitations present in the NES and other early consoles not as a boon, but as a blessing. The storage limitation of the NES led to the choice to score similar areas with the same music, i.e. above ground levels with the “Overworld Theme,” and underground levels with the “Underground theme,” etc. (“Nintendo Interview: Koji Kondo”).

Incredibly, the entire soundtrack of *Super Mario Bros.* makes up only three minutes of original music, yet it manages to accomplish so much in this short period of time. It does this with concise, catchy loops that have since become characteristic of video game music. These loops have evolved not only because of the limitation of storage, but because of the aesthetic goal to write music that completes and adds to a game or level without distracting from its gameplay (operating much in the same way that underscoring works within a film). A catchy loop manages to stay in the background while still adding a great amount to the player’s overall gaming experience. In this way, the imposed constraints of the NES’s storage limitations led Kondo to organize his soundtracks in more concise ways. Simultaneously, another limitation of the NES would challenge his compositional choices.

Secondary to the limitation of storage was the limitation of channels available on the sound chip of early consoles. On the NES in particular, there were five channels: “two pulse-wave channels, one triangle-wave channel, one noise channel, and one delta modulation channel (DMC)” (Schartmann 38). This equates to four instruments or voices, and with the noise channel usually used for percussion or sound effects, this left three that could produce discernible pitch, and therefore carry a line. The pulse-wave channels are square-waves, and usually carried the melody while the triangle-wave usually carried the bassline due to its lower range and fixed volume (39). While the DMC could be used to supply pre-recorded samples it was seldom used, because even small samples took up an immense amount of space and processing on the NES (38). This system is limiting for two primary reasons: harmony, and timbral variety.

First, the three channels (or voices) that could carry pitches constricted composers harmonically. If you wanted to construct a three-note chord (a triad), you were left with nothing to carry the melody. Therefore, it was very common for one pulse wave to carry the melody, another to have a countermelody, while the triangle wave outlined the bassline. Rather than limit his harmonic palette, Kondo instead (unconventionally) chose to imply 7th, 9th (four and five note chords respectively that often provide more “color” than the triad/three-note-chord that they are based on) and other extended harmonies reminiscent of his jazz influences. Kondo accomplished this by omitting certain voices to imply these more complex harmonies (Schartmann). This was in line with the views that he and other Japanese composers had on the limitations of the NES.

Well, as you know, the Nintendo Entertainment System had only three sound sources to work with, and it also had a very limited sound bank. Though what we tried to do was just really create different combinations using these limited resources to create images in the player's mind, or to have the player build up to something that would hopefully match with what they're playing, through those limited sound combinations ("Nintendo Interview: Koji Kondo").

Certainly, Kondo and his peers were innovative in their compositional choices, yet they did not challenge the systems that they worked with technically. Later on in the NES's lifetime, however, some companies such as Konami used sound drivers to get around the four-channel restriction in games like *Castlevania 3* (1989) ("Nintendo Interview: Koji Kondo"). Most Japanese composers, however, never wrote for a game that had audio drivers included in the cartridge and rather than attack them, accepted some of the limitations (such as the low number of voices). Rather than trying to alter or circumvent these constraints, they altered their compositional processes to construct their soundtracks while accommodating (and in many cases welcoming) some of the confinements that accompanied the technology.

This, however, was only one way of combating the limitations of the NES. Many American composers adopted a more technically head-on approach, aiming to evade some limitations with technical "tricks." Perhaps the best foil to Kondo's method, and his simple and sparse, yet simultaneously full-sounding, "Overworld Theme" in *Super Mario Bros.* is the "Level 1" theme from *Silver Surfer* (1990) by brothers Tim and Geoff Follin. Instead of accepting the limitation of three voices (and four channels) as Kondo and many others had, Tim Follin circumvented this limitation by making the "bass" and "drums" (or the sounds functioning as such) occupy the same channel, therefore freeing up the remaining channels to do other things (Schartmann 22). This "trick" was done

with some of the pulse waves as well, and allowed for the illusion of more voices/lines than there were channels available. This is one of the things, along with Tim Geoff's exciting use of simple effects like pitch bends, glissando, and panning, that made the soundtrack of *Silver Surfer* stand out, even amidst its mostly negative reviews due to the game's obscene difficulty (Morehead). As Brett Elston described in his GamesRadar.com article "Game music of the day: Silver Surfer," "This is beyond what anyone else was doing on the NES, both in technical prowess and quality of arrangement."

While most composers were focused on organizational triumphs over the NES, timbrally, many composers made a concession by conforming with the duty cycles of the console. The pulse-wave channels had four duty cycles: 12.5%, 25%, 50% and 75%, where the percentage refers to the percentage of time that the waveform is "on" relative to one complete cycle. Therefore, 25% and 75% duty are aurally indistinguishable, for they are simply inverses of one another (Schartmann 38-39). As such, composers essentially had three different timbres to choose from. *Mega Man 2*'s "Woodman Theme" illustrates these three timbres well, along with how composers attempted to use them to provide timbral variety and distinguish melody from countermelody, giving the track a much needed (and difficult to accomplish) depth.

Up until this point, we have mostly discussed compositional choices that had their roots in the limitations of storage and processing of the NES. While the NES primarily highlighted organizational and compositional innovation, the innovations surrounding the SNES were primarily related to timbre. Before we dive into some

examples, let's identify just how limiting that storage was through a look at the Super Nintendo.

The Super Nintendo was a huge upgrade from the NES in terms of audio. Rather than the single sound chip available in the NES, Nintendo had partnered with Sony to create the revolutionary S-SMP dual chip system. Compared with its predecessor, it had eight available channels (as opposed to four) and while still limited by today's standards, the sampling system was much more robust. This subsystem was not dependent on the relatively weak CPU of the SNES and could reproduce sounds that were far more realistic sounding than the FM synthesis of the six-channel Sega Genesis (Cicalese).

Despite its massive improvements over the NES, the SNES had a similar limitation of only 64kb of storage available for the music and sound effects of an entire game. For reference, the average three-minute mp3 today takes up 6MB, which is nearly 94 times the capacity of the NES and SNES, which were at the cutting edge of digital game audio ("How Music Was Made On Super Nintendo").

Circumventing this issue of storage to otherwise take advantage of the SNES's very advanced audio system was *Donkey Kong Country* (1994). Composer David Wise's use of non-functional harmony in his ambient tracks present throughout the game (and throughout the *Donkey Kong Country* series) was in large part only possible because of his innovation of wave-table synthesis.

In the early 90s, a synthesizer named the Korg Wavestation used a process called wave-sequencing that took a large number of tiny samples and arranged them to play in quick succession. This allowed for more complex timbres and envelopes than were

otherwise possible at the time. While literal wave sequencing was not possible on the SNES's sound chip, Wise was inspired by the idea of using very small samples arranged one after the other to allow for more evolving sounds over a period of time. To do this, Wise recorded individual waveforms at different levels and of different timbres to create a similar effect to wave-sequencing ("How Music Was Made On Super Nintendo"). This allowed for the smooth and timbrally interesting pads and sounds within tracks like "Aquatic Ambience." Similarly, in an interview with Ryan Hemsworth from Factmag.com, Wise explained that in "Stickerbrush Symphony" from *Donkey Kong Country 2: Diddy's Kong Quest* (1995) he "was trying to emulate filter sweeps and synth effects – which of course the SNES can't do as it doesn't have a resonant filter." It was in this way that Wise's ambition to push the technology to its limit allowed him to produce the unique and complex sounds that quickly became staples of his soundtracks.

While Wise was busy making inventive timbres to accompany a gorilla collecting bananas, Hiroki Kikuta took a different approach to achieve interesting timbres.

In making his first soundtrack, Hiroki Kikuta bent the Super Nintendo soundchip in truly bizarre ways. Making his own samples and stretching his skills to make songs that pulsed with the same teeming life that marked *Secret of Mana*'s verdant visuals, the result is a soundtrack that not only doesn't sound like anything else from the era but one that doesn't sound like anything else on the hardware.

As Anthony Agnello expresses above in his 2018 article "The 25 greatest video game soundtracks of all time" for Gamesradar.com, the soundtrack for *Secret of Mana* (1993) was one that was innovative for its use of timbre but in a more traditional way. Kikuta was able to replicate acoustic instruments, from piano to woodwinds to snare drums, with incredible accuracy. Certainly, these sounds are impressive before even considering

that these samples had to be incredibly short in duration and spectrally even more succinct given the cramped storage capacity of the SNES. Kikuta achieved this unparalleled quality by creating samples that matched the capabilities of Super Nintendo's S-SMP, which allowed him to compose the soundtrack "without worrying that his melodies would lose something in transposition from instrument to machine" ("The Best Soundtracks of the SNES Classic Era"). Indeed, "While the Super NES sound chip was better than anything found in other cart-based game machines of the time, few games used it as effectively as *Secret of Mana*" ("Games That Pushed The Limits of the Super Nintendo").

We have seen that composers for the NES and SNES may have differed in their approach, but they were always seeking to innovate, as they knew that this effort was one that would push their creativity to its bounds and allow them to create something truly unique. This is best expressed by Wise when he responded to a fan on Twitter who was asking if he felt that "systems like the NES and SNES held back [a] track's potential." Wise responded by saying "I certainly don't think the SNES held me back. I enjoyed the challenge of surpassing the limits. The positive effect being that it helped carve my style of video game music composition."

Little did Wise know that he and his colleagues would be helping to carve the style of video game music composition to come. While Wise, in particular, continues to have a very unique and recognizable sound, his influences, as well as Kondo's and other composers' of the 8- and 16-bit era, can still be heard in abundance today. Such influences, namely the use of non-functional harmony can be heard in other games

slightly later on in the SNES era, like *Chrono Trigger* (1995) as well as more recent tracks like "The Shard" from *Mirror's Edge* (2008), or the soundtrack of *Bastion* (2011). There is a key difference to be made, however, between influence and imitation.

Games like *Shovel Knight* (2014) aim to evoke the nostalgia of its players and pay homage to 16-bit classics like *Castlevania* (1986). Indeed the game has been called things like "a nigh-Platonic realization of an 8-bit side-scroller" (Peckham). This is present not only in the game's gameplay and graphics, but also in its soundtrack by *Mega Man* composer, Manami Matsumae ("Shovel Knight Avoids the Trap"). The timbres used throughout are very similar to that of *Silver Surfer*, *Mega Man 2*, and other examples that we've discussed. The character of the music is similarly bouncy, upbeat and adventure like, with square-wave melodic voices, a triangle-wave bass, and noise-based percussion. Like Kondo, Matsumae's soundtrack is organized by area, with different environments having different tracks. All of this being said, there are some qualities that separate it from its predecessors with reviewers calling the platformer an "NES game you've never seen, a time machine back to an alternate history where 8-bit NES games ran on 1920-by-1080 pixel flat-screens" (Peckham) and "Aesthetically antiquated but still smartly modern" ("Shovel Knight Avoids the Trap"). Perhaps the most obvious difference is the game's use of polyphony; right off the bat in the "Title Theme," one can clearly hear voices/lines, and even harmonics within the synths that were not available to the composers of the late 80s and 90s. So while *Shovel Knight* aims to emulate these soundtracks, it has the updated sound quality and execution of more modern technology.

These modern influences can be more clearly and readily seen in *Celeste* (2018). Where *Shovel Knight* uses timbres and organization more traditionally used in the soundtracks of earlier consoles, *Celeste*'s composer, Leina Raine, manages to strike a blend of these influences with more contemporary practices. So while *Shovel Knight* screams its influences from the highest tower, *Celeste*'s influences are a more nuanced whisper. A discussion of the track "Resurrections" will serve to illustrate this.

The track opens with a synth that is somewhat similar to those used in 16-bit games, yet it is already richer sounding and drenched in reverb and delays. The sampled percussion and piano VST that soon support this synth melody would not only have been very out of place in these earlier titles, but would have been technically impossible given the number and size of the samples used. All of these layers ultimately combine to form a richness and thickness in an arrangement that otherwise was simply impossible due to the limitations of channels that we have previously discussed. This sonic depth was accomplished in individual parts as well, by layering many patches to construct the complex timbres of *Celeste*'s synths. Raine highlights this layering in her music and separates it from traditional "Chiptune" in her article "A Little Bit About *Celeste*'s Synths" for Medium.com, explaining that her synth patches (and synthesizers in general):

use the same general sound origins as chips, BUT! [have] A multitude of tweakable parameters, knobs, effects, and the ability to patch to different modules and oscillators to create a more complex, layered sound." where in "chiptune"... everything is contained within the chip itself. There are no external settings or knobs or patching that can be used to layer or modify the sound.

While Raine concedes that “There’s an inspiration style-wise for sure,” she clarifies that the depth achieved in her soundtrack was an impossibility of earlier chiptune present in systems like the NES, Genesis, or Gameboy.

However, while “Resurrections” utilizes both the lack of a channel/track limit in today’s DAWs, and the “tweakable parameters” of modern synthesizers, it still has a relatively small amount of moving parts. Most of the additional layers serve to intensify the timbre of the melodies, counter-melodies, and harmonies, but the compositional choices are largely similar to those made for earlier consoles. The soundtrack as a whole is reminiscent of Wise’s style in how the synth envelopes evolve over time and Raine showcases a similar sense of timbral and harmonic exploration. “Resurrections” uses a Major-minor seventh chord as its tonic or “home-chord.” For those unfamiliar with music theory - don’t panic - this is just a rather dissonant chord to use as a tonic. This choice helps to give Raine’s track a similar sense of movement to that seen in many of Wise’s pieces, as even when a loop is completed there is not a strong sense of resolution. Instead, the chord still has a questioning and eerie sound that wants to move somewhere, but again like in Wise’s music, the motion to this somewhere is non-functional yet smooth. This is to say that while the chords don’t necessarily fall nice and tidy into a traditional western scale or understanding of harmony, thanks to the proximity of neighboring chords to one another, the overall progression still feels somewhat natural and satisfying, if a bit odd at first.

Clearly, while the composers of soundtracks for early console games had different approaches and priorities to realizing their scores on these systems given the

technological obstacles, they similarly chose to approach the constraints as challenges, graciously receiving the limits that it placed on the limitless possibilities of writing music. Whether they chose to accommodate these limitations and overcome them with organizational choices like Kondo, or attack the limits head-on to achieve something timbrally new and compelling like Wise, all of these composers understood the positive effect that constraints could have on their creative process. Today, even in the absence of these more constrictive confinements faced by video game music composers in the 80s and 90s, this similar attitude towards limitations on one's creativity is one that remains omnipresent among composers today.

Despite the amount of sounds now available to modern composers, the sense of timbral exploration is one that is alive and well... or is it? On one hand, it is easier to create something new sounding when there are so many more tools and sounds and far fewer constraints placed on composers. On the other hand, however, this plethora of options that composers have thanks to these tools can be overwhelming, and can prompt them to take the easy way out by reproducing something similar to their own past works or those of other composers rather than make something truly new sounding. Many composers use the same tools, or have VSTs or instruments that create similar effects. Leina Raine's use of software like Native Instrument's Massive and Spitfire's library of virtual instruments are standards in the virtual backpack of nearly every video game music composer nowadays (Paquet). This leads to a situation where a large portion of video game music sounds timbrally or aesthetically similar.

Consequently, an increasingly common criticism of video game music today is that it sounds increasingly “cinematic.”

While the gameplay driven games of early consoles that had protagonists like gorillas or Italian plumbers with little (logical) context, games today are often increasingly based in their narrative. This is not a negative on its own, but is one aesthetic shift that has led to soundtracks of games becoming what some would call increasingly “generic” and over-the-top emotionally (“LET'S ARGUE: Video Game Music Is Getting Worse”). Indeed, as we’ve seen with our modern examples, the soundtracks that stand out are often those that are timbrally or organizationally interesting. So while composers today no longer have to make a technical innovation to stand out, with more games being released every day, they still have to make timbral or organizational choices that serve to distinguish their work from the pack.

This suggests that the reason that many older soundtracks of the NES and SNES eras are so fondly remembered is indirectly due to the limitations that they faced. When composers had only three timbres to choose from, their composition had to be much more melodically and structurally solid, as imperfections in their composition would only be brought to the forefront when realized on these 8- and 16-bit consoles. In the richer, reverb and effects drenched soundtracks of today, there is more wiggle room in which to hide these shortcomings. Some of the more cinematic music of today can be much more forgettable, as more and more composers commit to this “cinematic” aesthetic. While some may say that nostalgia colors the opinions of soundtracks from

the 80s and 90s (and it surely does) it is interesting to consider how aesthetic influences have made certain modern soundtracks stand out from the rest.

WC: 4632

Youtube Playlist: <https://bit.ly/2IzqdmX>

Works Cited

Agnello, Anthony John. "Shovel Knight Avoids the Trap of Retro for Retro's Sake."

Games.avclub.com, Avclub, 23 Aug. 2017,

games.avclub.com/shovel-knight-avoids-the-trap-of-retro-for-retro-s-sake-1798269891.

Agnello, Anthony John. "The 25 Greatest Video Game Soundtracks of All Time."

Gamesradar, GamesRadar The Games, Movies and TV You Love, 18 May 2018,

www.gamesradar.com/the-25-greatest-video-game-soundtracks-of-all-time/.

Arsenault, Dominic. *Super power, spoony bards, and silverware: The super nintendo entertainment system*. MIT Press, 2017.

Bastion. Supergiant Games, 2011.

Castlevania 3. Konami, 1989.

Celeste. Matt Makes Games, 2018.

Chrono Trigger. Square, 1995.

Cicalese, Louis J. V. "Top 6 SNES Innovations (That Left Nintendo's Competitors in the Dust)." *Top 6 SNES Innovations (That Left Nintendo's Competitors in the Dust)*,

256kilobytes, 18 Feb. 2019,

www.256kilobytes.com/content/show/3094/top-6-snes-innovations-that-left-nintendos-competitors-in-the-dust.

Cunningham, Andrew. "The NES Turns 30: How It Began, Worked, and Saved an Industry." *Ars Technica*, ARSTechnica, 15 July 2013,

arstechnica.com/gaming/2013/07/time-to-feel-old-inside-the-nes-on-its-30th-birthday.

Donnelly, Kevin J., William Gibbons, and Neil Lerner, eds. *Music in video games: Studying play*. Routledge, 2014.

Donkey Kong Country. Rare, 1994.

Donkey Kong Country 2: Diddy's Kong Quest. Rare, 1995.

Donkey Kong. Nintendo, 1981.

Elston, Brett. "Game Music of the Day: Silver Surfer." *Gamesradar*, GamesRadar The Games, Movies and TV You Love, 2 Oct. 2010, www.gamesradar.com/game-music-of-the-day-silver-surfer/.

Fantano, Anthony. "LET'S ARGUE: Video Game Music Is Getting Worse." *YouTube*, YouTube, 26 Feb. 2019, www.youtube.com/watch?v=FB8-mJyaHsQ.

"Games That Pushed The Limits of the Super Nintendo (SNES)." *RetroGaming*, Racketboy, 10 Mar. 2018, www.racketboy.com/retro/super-nintendo-snes-games-that-pushed-the-limits-graphics-sound.

"How Music Was Made On Super Nintendo." *Youtube*, uploaded by Nerdwriter1, 15 Aug 2018, <https://www.youtube.com/watch?v=jvIzIAGRWVo>.

Mega Man 2. Capcom, 1988.

Mirror's Edge. Electronic Arts, 2008.

“Miyamoto on World 1-1: How Nintendo Made Mario's Most Iconic Level.” *Youtube*,

YouTube, 7 Sept. 2015,

www.youtube.com/watch?time_continue=484&v=zRGRJR UWafY.

Morehead, Jason. “The Silver Surfer Soundtrack Is Classic NES Music at Its Best.” *Opus*,

Opus, 7 Mar. 2019,

opuszine.us/posts/silver-surfer-soundtrack-classic-nes-music-at-its-best.

“Nintendo Interview: Koji Kondo.” *Nintendo Interview: Koji Kondo*, Rovi Corporation,

10 May 2007,

web.archive.org/web/20131007211957/http://archive.videogamesdaily.com/features/koji_kondo_iv_p1.asp.

Paquet, Ryan. “INTERVIEW: Composer Lena Raine Talks Celeste Soundtrack &

Working in Game Audio.” *Original Sound Version*, Original Sound Version,

www.originalsoundversion.com/interview-composer-lena-raine-talks-celeste-soundtrack-working-in-game-audio/.

Peckham, Matt. “8-Bit Homage Shovel Knight Is a Crowdfunded Home Run.” *Wired*,

Conde Nast, 3 June 2017, www.wired.com/2014/06/shovel-knight-review/.

Plafke, James. “How the 16-Bit SNES Competed in a 32-Bit Era.” *Geek.com*, Geek.com, 1

Apr. 2014,

www.geek.com/games/how-the-16-bit-snes-competed-in-a-32-bit-era-1589775/.

Raine, Lena. “A Little Bit About Celeste's Synths (And Some Bonus Piano).” *Medium*,

Medium, 27 Dec. 2018,

medium.com/@kuraine/a-little-bit-about-celestes-synths-and-some-bonus-piano-461f62605ea1.

Rossen, Jake. "How Nintendo Conquered Manhattan in 1985." *Mental Floss*, Mental Floss, 20 Mar. 2015, mentalfloss.com/article/62232/how-nintendo-conquered-manhattan-1985.

Schartmann, Andrew. *Koji Kondo's Super Mario Bros. Soundtrack*. Bloomsbury Publishing USA, 2015.

Secret of Mana. Square, 1993.

Shovel Knight. Yacht Club Games, 2014.

Silver Surfer. Software Creations, 1990.

Space Invaders. Taito, 1978.

Super Mario Bros. Nintendo, 1985.

"The Best Soundtracks of the SNES Classic Era." *Turtle Beach Blog*, Turtle Beach Blog, blog.turtlebeach.com/the-best-soundtracks-of-the-snes-classic-era/.

Trautman, Ted. "Excavating the Video-Game Industry's Past." *The New Yorker*, The New Yorker, 20 June 2017, www.newyorker.com/business/currency/excavating-the-video-game-industrys-past.

Whalen, Zach. "Play Along - An Approach to Videogame Music." *Games Studies 0101: Games*.

Wise, David (@David_Wise). "I certainly don't think the SNES held me back. I enjoyed the challenge of surpassing the limitations. The positive effect being that it helped

carve my style of video game music composition.” Apr 3, 2018, 2:52pm. Tweet.