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Patrick LeMieux

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PATRICK LEMIEUX

> .-- .... .- -   .... .- - ....   --. .. -..   .-- ... .- --. .... -[1]
>
> —Samuel F. B. Morse, May 24, 1844

> A game is input->output. Repeat. Each cycle of this costs 1 unit time. A game also has a state. The game state is the memory. All of the variables. One game state may be observed and agreed upon as the 'start.' Another may be observed and agreed upon as the 'end.' Measuring the number of input->output cycles that occur between the 'start' and 'end' is a speedrun. The goal of a speedrun is to lower this as much as possible.
>
> —Cosmo Wright, July 24, 2014

Introduction

Input 1 then Input 2 then Input 3 in Frame 1. Frame 1 then Frame 2 then Frame 3 in Level 1. Level 1 then Level 2 then Level 3 in World 1. World 1 then World 2 then World 3 in Game 1. Game 1 then Game 2 then Game 3 in Franchise 1. Franchise 1 then Franchise 2 then Franchise 3 in Platform 1. Platform 1 then Platform 2 then Platform 3 in the serial history of videogames. Although play is irreducible, games repeat. Alongside newspapers, magazines, comics, novels, albums, television programs, films, and even websites, industrial forms of seriality structure the diachronic production and synchronic consumption of videogames as a mass medium. Whether taking the form of a succession of actions, a set of levels, or a series of games, the term *seriality* can refer to both a sequence of two or more objects in time or the similitude between two or more objects in space—twin effects of mechanical production. Produced in mass yet consumed individually, the repeating elements of serial media like Nintendo's *Super Mario Bros.* (1985) both reproduce and reduce specific instances of play to generalizable sequences of serial pulses sent both to and from standard controllers. Aside from the haptic sensation of fingers pressing plastic and the physicality of phosphors glowing on the surfaces of CRT screens, games repeat. From subsecond sampling and sequencing of button combinations to the conspicuous consumer culture surrounding videogames as commodities, serial games operate both under and over individual experience, abstracting the specific phenomenal, material, and historical qualities of play into abstract quantities that repeat in time and space. As Jean-Paul Sartre (2004, p. 262) writes, these serial forms of industrial culture "are lived separately as identical instances of the same act."[2]

Eludamos Vol. 8, No. 1 (2014)
pp. 7-31

In “Digital Seriality: On the Serial Aesthetics and Practice of Digital Games,” Shane Denson and Andreas Jahn-Sudmann differentiate three forms of “ludic seriality” based on three scales of industrial repetition in games. Using *Super Mario Bros.* as an example, their tripartite schema includes “intra-ludic seriality, which manifests itself *within* games” (e.g., the sequence of stages, levels, and worlds inside a given game like Level 1-1, 1-2, and 1-3); “inter-ludic seriality, which emerges *between* games” (e.g., the relationship between sequels, prequels, and remakes which extend a series of games like *Super Mario Bros. 1, 2,* and *3*); and “para-ludic seriality, which is constituted *outside* of the actual games” (e.g., the transmedial and largely fan-produced works that exceed the artificial corporate boundaries of a game as an autonomous, consumer object not unlike Gérard Genette’s concept of “paratext”) (emphasis original, Denson and Jahn-Sudmann 2013, p. 11). Although these forms of ludic seriality are not unique to digital media, the incredible speeds of serial interfaces and widespread distribution of videogames transform industrial modes of spatial and temporal reproduction into what Denson and Jahn-Sudmann characterize as “digital seriality.” Digital seriality hinges on “the microtemporal scale of individual players’ encounters with algorithmic computation processes (the speed of which escapes direct human perception and is measurable only by technological means)”—or “serial interfacing”—and “the macrotemporal (more properly ‘historical’) level of collective brokerings of political, cultural, and social identities in the digital age”—or “collective serialization” (Denson and Jahn-Sudmann 2013, p. 1). Operating both below and above the bandwidth of conscious experience, the serial interfacing and collective serialization of videogames structure and enclose play without the player’s explicit knowledge—a form of alienation that Bernard Stiegler (2010, p. 45) calls “systemic stupidity.” From Nintendo’s NES-4021 shift register to Morimoto’s moSMB.wmv viral video, this essay explores the history and practice of “tool-assisted speedrunning,” a form of metagaming that plays the serial interface.

NES-4021

Press “START.” Sixty times a second[3] an electrical impulse is sent from the Nintendo Entertainment System (NES)[4] to the sixth pin of its first controller port. From port to plug to cord to controller, the signal travels down one of five colored wires to the NES-4021, an 8-bit, parallel-to-serial shift register housed within a standard controller (see Figure 1). After receiving a high pulse for 12 microseconds[5] from the orange wire connected to pin six, the 4021 “latches” the state of the controller’s eight buttons and immediately sends a single pulse of electricity back to the NES along the yellow wire, pin seven. This pulse represents a single bit of serial data. An absent or “low” current pulse (i.e., 0V), is interpreted as a 0 by the NES’s central processing unit (CPU)—a modified version of MOS Technology’s popular 6502 processor called the Ricoh 2A03. A “high” current pulse (i.e., +5V) is registered as a 1. Although digital media are never quite digital, the infinitely individuated physical attributes of electrical current are measured, sampled, and abstracted into serial units by mechanisms like the flip-flop circuits of the 4021 and the semiconductor arrays of the 6502’s input/output registers.[6] As Matthew Kirschenbaum (2008, p. 61) confirms in *Mechanisms: New Media and the Forensic Imagination*, “while bits are the smallest symbolic units of computation, they are not the smallest inscribed unit.”[7] Serial communication, however, privileges the discrete, repeatable bit over the continuous flows of electricity. Surges, spikes, static, and other forms of interference are either ignored by the processor, translated into bits by the processor, or crash the processor—there is no middle ground.[8] Press "START." A continuum of analog phenomena is reduced to the discrete differences that characterize digital media. In the case of this input in this frame of this game on this platform, if the first electrical current measured by the CPU after "latching" is above a certain threshold, the 6502 registers a 1 at memory address $4016. Sent one at a time, always in the same order, the CPU registers the states of each button starting with "A." If the last bit of memory at $4016 is a 1, the "A" button was not pressed.[9]

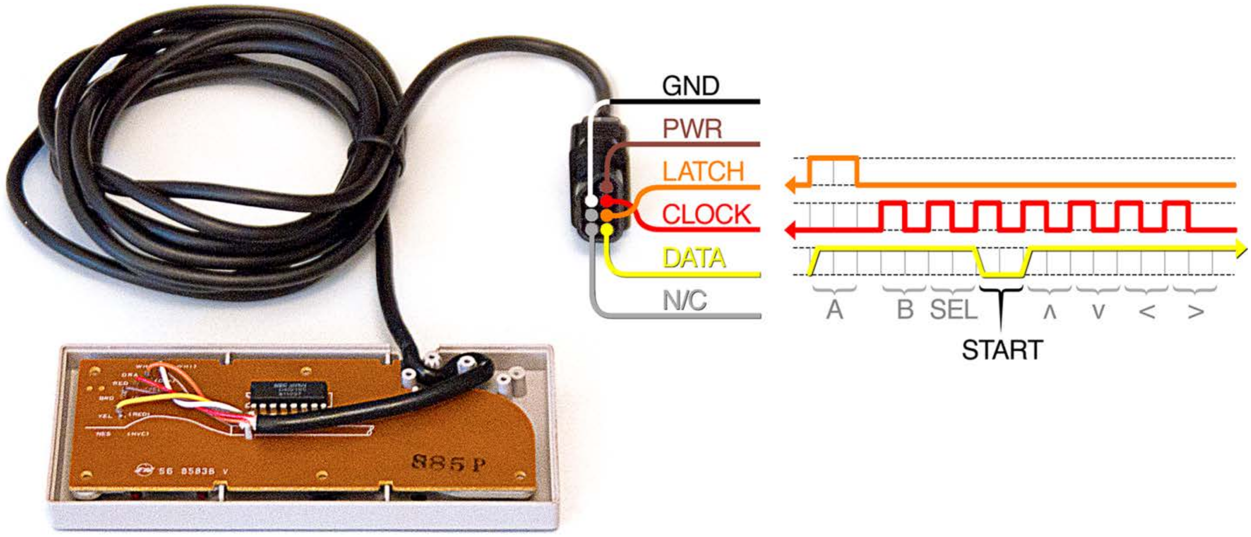

Figure 1. The 4021 parallel-to-serial shift register in a Nintendo Entertainment System controller (left) converts the collective state of eight buttons to a serial stream of electrical pulses transmitted over a single yellow wire (right).

Press "START." Exactly 6 microseconds after the "A" value was registered by the Nintendo's CPU, there are still seven values "latched" to the shift register. The remaining buttons are relayed in order and one at a time, according to a series of short pulses (interleaved with pauses) that the shift register receives from the fifth pin, the red wire. For each 6-microsecond tick of this "clock" the next bit of data is shifted forward then serially transmitted to the NES along the yellow wire. Tick, tock, tick, tock, tick, tock, tick. High, high, low, high, high, high. 1, 1, 0, 1, 1, 1, 1. "B" was not pressed. "SELECT" was not pressed. "START" was pressed. "UP" was not pressed. "DOWN" not pressed. "LEFT" not pressed. "RIGHT" not pressed. A final "tick" is sent to complete the sequence. In 108 microseconds (about one ten-thousandth of a second), one "latch" and eight "clocks" were serially "written" to the controller and, in return, eight bits of data were serially "read" by the NES. Every sixtieth of a second, eight more bits representing the states of eight buttons are polled by the NES-4021 then sent serially from the controller to the 6502 processor. Again and again, the states of eight simple contact switches are relayed in sequence at the last bit of memory at CPU address $4016. These values are (typically) inverted and accumulated into a single byte of RAM for future reference. The future, in this case, is very short. If $4016 reads 1, 1, 1, 0, 1, 1, 1, 1, and those values are stored as 00010000 (written as 10 in hexadecimal), then “START” was pressed. If “START” was pressed, perhaps a software routine will begin the game. The sweaty palms, particular grip, and proprioceptive experiences of the player must be translated into digital data. The phenomenology, materiality, and physicality of play must be sampled, serialized, and stored as bits before it can impact the operation of the videogame. Within the sixtieth of a second between pressing start and the game starting, serial operations unfold at scales and speeds outside the consciousness of the button masher.

Press “START.” On the Nintendo Entertainment System, the interface between player and game, between pressing start and the game starting, is serial. Whereas parallel communication requires synchronizing or “linking” two or more communication channels in order to send multiple bits of information at the same time, “serial communication consists in transmitting a single bit of data at a time, sequentially, forming a serial data stream” (Advantech 2012). From smoke signals and distant drums to transatlantic telegraph cables and the RS-232 standard in computing, long-distance communication is often mediated by a serial interface. Beyond the mere presence or absence of smoke, sound, or signal (which is nevertheless a historically important, albeit rudimentary form of serial data), a second order of complexity emerges in serial communication with time. Morse code, for example, is not only based on repeating tones, but repeating times. The difference between a “dot” and a “dash” is not only defined in terms of the presence or absence of a signal but the division of otherwise undifferentiated durations into repeating, increments. Just as a bit is produced by switching mechanisms such as transistors and shift registers, time is produced by strobing mechanisms such as resonating crystal oscillators. Although a single plume of smoke on the horizon transmits information, the production of temporal patterns within a continuous signal (like covering and uncovering a signal fire with a wet blanket), can expand the message from either 0 or 1 to a series of 0s and 1s able to encode a variety of formal symbols. In order to be decoded on the receiving end, serial communication requires temporal standardization to synchronize not only bits between storage media, but also “ticks.” In 1962, the Electronic Industries Association (EIA) published the “Interface between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange” otherwise known as RS-232, a standard that entails

1. the electrical signal characteristics
2. the interface mechanical characteristics
3. a functional description of the interchange circuits
4. standard interfaces for selected communication system configurations (Wood 1981, p. 301)

Originally implemented to connect teletype machines to early modems, the RS-232 Standard also informed the design of the serial connection and serial cable shipped with the original IBM PC as well as the PS/2 interface for mice and keyboards, Firewire and USB for data transfer, Ethernet for networking, and, of course, the serial protocol for most videogame controllers.

The NES controller is both a serial interface and an example of Denson and Jahn-Sudmann's concept of "serial interfacing." For Denson and Jahn-Sudmann (2013, p. 11), serial interfacing qualitatively describes the "processes of temporal-serial experience that transpire at the interface between humans and digital technologies." This essay explores at greater length how forms of digital seriality also occur between nonhuman actors. Between the temporary storage of bits "latched" to shift register and the bits registered in the CPU's memory (two, independent forms of synchronic seriality), there also lies the diachronic, serial interfacing of pulsing currents. These nonhuman serialities provide technical scaffolding for the emergence of interactions between human players and networked and programmable media. Following Henri Bergson's distinction between temporality as process and temporality as measured, N. Katherine Hayles (2012, p. 86) asks:

> Along what time scales do interactions occur between humans and technical objects, specifically networked and programmable machines? What are the implications of concatenating processual and measured time together in the context of digital technologies? What artistic and literary strategies explore this concatenation, and how does their mediation through networked and programmable machines affect the concatenation?

Perhaps nowhere in the culture around videogames are these questions of both human and nonhuman temporality better explored than in the relatively new (and intertwined) practices of speedrunning and tool-assisted speedrunning. Related to both Henry Lowood's (2006, p. 26) "high-performance play" (i.e., "play as performance, modification of content, and community-based tools and content development") and James Newman's (2008, p. 124) "superplay" (i.e., "the use of the knowledge and techniques uncovered and laid out in Game Guides, the exploitation of the structures, [non-] linearity and limitations of videogames as designs as well as the harnessing of glitches in game code"), speedrunning and tool-assisted speedrunning are community practices which add voluntary constraints to the involuntary mechanics driving digital games, convert videogames from games in and of themselves into equipment for playing larger games, and turn play into a game design practice. These games played in, on, around, and through other games are metagames. While digital seriality articulates the character of videogames as a technical and mass medium, metagames locate the specific, material histories of 21st-century play. Extending Richard Garfield's definition of metagames from "how games interface with life" to "how games *serially* interface with life," tool-assisted speedrunning exemplifies how community practice can both identify and challenge the serial structures governing all videogames (Garfield 2000, p. 1).[10] Metagames like tool-assisted speedrunning remake and remediate videogames according to the conscious choices of small communities rather than the rules of serial consumption. In the case of the *Super Mario Bros.* franchise, the history of speedrunning and tool-assisted speedrunning console games began with a viral video that circulated in 2003.

moSMB3.wmv

Not long after .GIFs of dancing babies (and dancing bananas and dancing hamsters) colonized Geocities websites in the late nineties and "all your base belonged to us" in

2001, a serial Mario meme spread across the Internet alongside *Star Wars Kids* and *Badger Badger Badgers* in 2003. Titled moSMB3.wmv, the 18.4-megabyte Windows Media Video file was traded via torrents, uploaded to university accounts, and, of course, exhibited on eBaum's World as "Super Mario 3 beat in 11 minutes." Before Leroy Jenkins and lonelygirl15 were streaming videos on YouTube in 2006, eBaum's World was one of the earliest entertainment aggregators that hosted—and on more than one occasion claimed to author[11]—much of the early history of Internet memes. Posted in the "Hilarious Video" section of the website on December 3, the .WMV came with a warning: "[t]his video is a very large file and will take 3 hours to download if you are on a slow dial up internet connection. Broadband users only!" (eBaum's World 2003) (see Figure 2). Although moSMB3.wmv is a derivative work based on the third entry of a widely disseminated videogame franchise, these aspects of industrial production and distribution are not unique to digital seriality. Downloaded bit by bit from a central server, the speed and scale of TCP/IP protocol exemplifies one aspect of digital seriality: the diachronic repetition of modular units, rapidly transmitted in vast sequences of 1s and 0s which characterize serial interfacing. Once magnetically etched into the spinning platter of a hard drive client side, moSMB3.wmv enacts a second, related aspect of digital seriality: the synchronic storage of copied data accessed simultaneously on separate screens in the form of collective serialization. From the speed and scale of information exchange to the private experience of consuming media, Internet memes are perhaps one of the best examples of the diverse spatial and temporal modes in which seriality operates. Without the crowd sourced "liking," "upvoting," or "retweeting" now common to the production and consumption of memes within social media networks such as Facebook, Reddit, and Twitter, file trading produced an audience of individuals, separated by the industrial conditions structuring the transmission of files. Beyond the serial production and networked consumption of viral video, moSMB3.wmv, a speedrun of Nintendo's *Super Mario Bros. 3* performed by a Japanese player known as Morimoto (もりもと), reveals the alienating effects of digital seriality and dramatizes the distinction between human and machine scales of temporality.

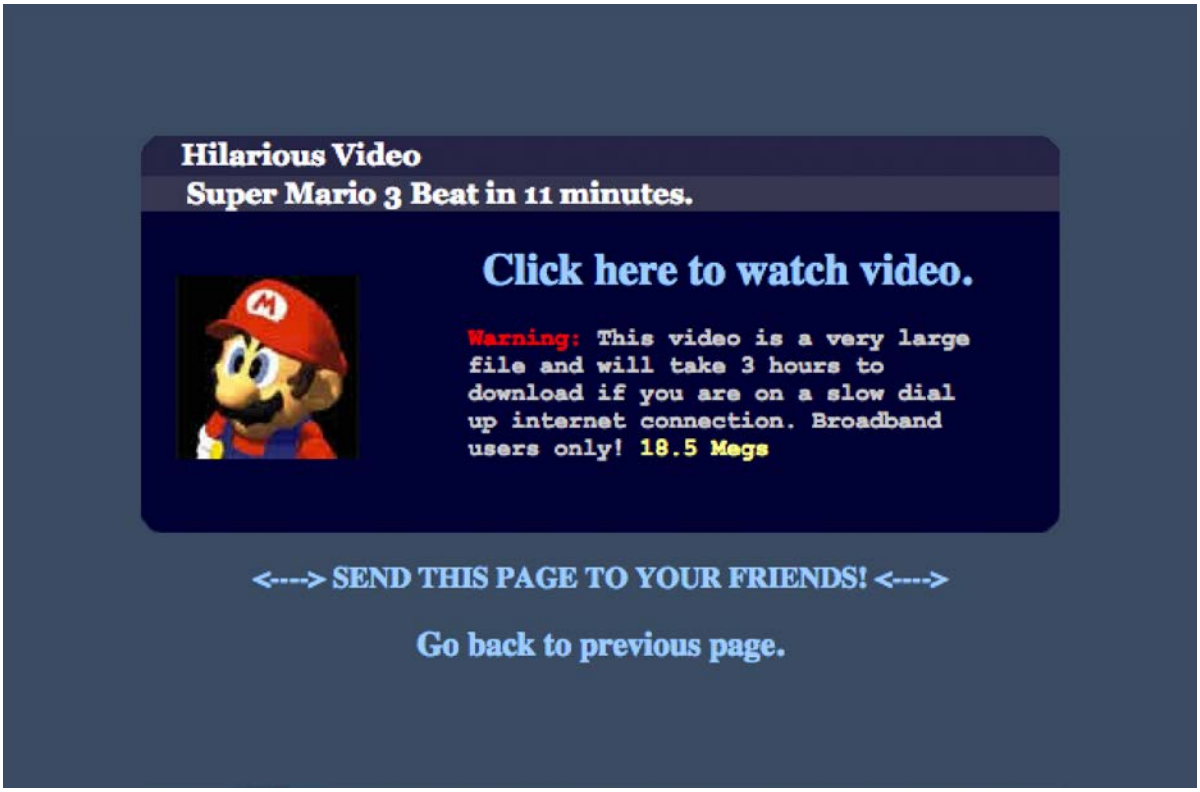

Figure 2: On eBaum's World, Morimoto's "Hilarious Video" was rehosted without attribution and with a broadband warning.

After downloading the file (for what might have been hours) and getting the video to play (after also downloading the proper codec),[12] Morimoto's speedrun begins with the faint sound of the start screen of *Super Mario Bros. 3* accompanied by a white overlay with two lines of green, right-justified text: "super mario bross3 [sic] / time attack video" (see Figure 3). As the overlay dissolves into the World 1 map screen, the first stage is quickly selected and Mario glides through Level 1-1 with mechanical precision. The tiny, four-tone sprite scrolls right at a constant rate of 3.5 pixels per frame,[13] effortlessly avoiding obstacles and bouncing off enemy after enemy before reaching his goal in the first three stages of Grass Land. After two minutes of gameplay and two warp whistles, Mario has already entered World 8 and is nearing the end of his quest to rescue the princess. Instantly transported from the pastoral fields and benign obstacles of World 1 to the dark, industrial hell of what is ostensibly Bowser's home turf,[14] Mario starts to really show off. The final world of *Mario 3* begins three "autoscrollers"—levels in which the screen moves at a fixed rate to simulate the procession of wooden tanks, ships, and planes that make up the Koopa King's army. Since speed is constrained to the slow panning of the stage, rather than simply pressing his nose against the rightmost pixel of the frame, Mario bides his time by bouncing acrobatically from bob-omb to bob-omb to cannonball and back, racking up thousands of points and extra lives. Whereas the streamlined speedrun through the first three levels seemed practiced, Mario's death-defying antics and carefree hot-dogging at the end of the game are downright superhuman. The first stage of the Dark Land is completed with 79 lives. The entire game is over in eleven minutes, three seconds, and ninety five milliseconds—exactly 39,837 frames—and fades to another white slide with green credits: “played by もりもと / @やるきなす / http://soramimi.egoism.jp/ / http://homepage3.nifty.com/nura/.”

Figure 3: Screenshots from moSMB3.wmv reveal the low resolution and high compression of Morimoto’s original movie file, adapted for the speed and scale of file sharing in the early 2000s.

When Morimoto first released the video in late November 2003, direct links from the popular Japanese bulletin board 2channel (http://2ch.net)[15] quickly exceeded the bandwidth limits of his personal website. Scrambling to subsidize server costs with online advertisements on November 28, Morimoto lamented, “the end of the world is near” (Morimoto 2003). Five days later, on the other side of the world, moSMB3.wmv was rehosted on eBaum’s world and downloaded thousands of times. Although consumed privately, the collective serialization was captured across various web forums and online communities. Initially viewers were dumbfounded by the spectacle of such play:

> OH MY GOD... i cant beleive what i just saw.. this guy is awesome and at the same time SCARY.. i cant put this into words only one WOW!!!! (Yessie 2003)[16]

> Pure madeness. Gods among men... yes. Super l337-human powers? Yes. (NSPIRE 2003)

> If I didn’t know any better I’d say he knew the position of every gumba, cannonball, and man-eater plant int he whole game!!! (5stringdna 2003a)

> The jumping was amazing. He finished with 99 lives . . . I considered myself a Mario nerd, but I never knew about the first whistle he gets, the walk-through-the-wall thing he does on the last level, or the fact that you can kill Bowser by jumping on him enough times. (Erroneus 2003)

> h4x!!!!!! (Sonic 2003)

As is already evident in the preceding posts, there was a pervasive sense of disbelief that morphed into a kind of antipathy towards the player who performed such virtuosic, yet “alien” play:

> :shock: that’s inhuman... that's just wrong..... (nublu01 2003)
>
> I think some things are better left alone or untold so they don’t shatter peoples’ hopes and dreams. I cried tears of joy when I saw that. (fizzlephox 2003)
>
> Morimoto-sama, I bow before thee... even though to get this good, you must have wasted an incredible amount of your life. ::mourns this Morimoto person:: tongue.gif (Spectrum 2003)
>
> Ok, so if this guy spent an equal amount of time doing something like, kung-fu or whatever, he coudl be the grand-master mac-daddy, but instead he's decided to master an 8-bit nintendo game? (5stringdna 2003b)
>
> *Cough “No life!” (Toddathon 2003)

Skepticism and sarcasm gave way to overt racism:

> I think the guy that did that is japenese or chinese, notice its not the english version of the game. Either that or it's done on an emulator and he didnt get the english rom. (Vamp 2003)
>
> :eek: :wtf: :eek: :wtf: :eek: That was 100% FLAWLESS. As I watched that, I asked myself... “what human being possesses such robotic precision?” Then I saw the Japanese writing at the end, and it all made sense… (Bluefire 2003)
>
> It’s about an extremely lonely man who had nothing but his Nintendo, a 2 liter, and a desire to be the best at his craft. . . . With a little determination and love (and absolutely no desire to ever leave his home prefacture), this wacky asian man was able to conquer Super Mario 3 in 11 minutes and some odd seconds. . . . Easy peezy Japaneezy. (Snaggletooth 2003)
>
> teh japanese are :alien: (Ilitirit 2003a)

The attitudes surrounding an “alien” invasion onto the site of traditional play are in keeping with the projection of techno-Orientalist anxieties common to science fiction like William Gibson’s *Neuromancer* (1984) and Ridley Scott’s *Blade Runner* (1982). In adjacent posts, Morimoto is described as a “cybernetic soldier,” “made in germany and exported to japan,” and “designed on a genetic level to destroy joysticks” as posters channel racist characterizations that “[t]he Japanese are unfeeling aliens [...] cyborgs and replicants” (PhazeORage 2003, Iliterit 2003b, Riot999 2003, Morley and Robins qtd. in Sohn 2008, p. 7). As Stephen Hong Sohn (2008, p. 6) points out, “the connection between the Asian American and the alien other still remains a force to draw upon to allegorize racial tension and exclusion.” Analyzing how both “alien” and “Asian” are entangled concepts within the contemporary Western imaginary, Sohn (2008, p. 6) further emphasizes, “Alien/Asian does invoke conceptions of its homonymic counterparts, alienation and alien-nation.” In terms of Sartre’s theory of seriality, alienation is the effect that both distances producer from produced (or player from play) and separates individuals from community group formation—literally forming alien nations behind the folds of newspapers (or perhaps in today's context, the glowing screens of smartphones). MoSMB3.wmv continues this tradition digitally. Both the spectacular play and the hostile spectatorship function together to allegorize the alien and alienating effects of serial interfacing as speculations about Morimoto's racial identity ultimately stand in for the technological apparatus of "tool-assisted speedrunning," a form of metagaming that attempts to play the serial interface at human conscious timescales.[17]

Tool-Assisted Speedrunning

In *Alien Phenomenology, or What It's Like to Be a Thing* (2013), Ian Bogost deploys the figure of the alien to different effect. Working alongside the anti-correlationist philosophies of Graham Harman and Levi Bryant, Bogost (2013, p. 34) argues that "[t]he true alien recedes interminably even as it surrounds us completely. It is not hidden in the darkness of the outer cosmos or in the deep-sea shelf but in plain sight, everywhere, in everything." Although this claim privileges chips and circuits as much as coffee cups and ice cream cones, videogames like Atari's *E.T. the Extra-Terrestrial* (1982) feature heavily in Bogost's book. For Bogost (2013, pp. 17-18), *E.T.* is "8 kilobytes of 6402 opcodes and operands," "a flow of RF modulations," "a molded plastic cartridge," "a consumer good," "a system of rules or mechanics," "an interactive experience," "a unit of intellectual property," and "a sign that depicts the circumstances surrounding the videogame crash of 1983." A similarly irreducible, alien assemblage of technical media and cultural significance, in the early 2000s Internet users confronted the profound disconnect between their own lived experiences of *Super Mario Bros. 3* as a consumer good and its uncanny technical capacities. After initial reactions of stunned disbelief and racist speculation, forum threads settled into a more analytic approach to the video as almost all posters were learning about a metagaming practice called "tool-assisted speedrunning" for the first time:

> . . . there are some things that i don't think add up in the video, but i'm not sure if i should start listing, since there might be a chance no one really played the game here. Are there any experienced mario 3 players out there that think there's something's wrong with the video? (KQX 2003)
>
> I've not done any reading on the matter but I am quite convinced (having played a LOT of mario 3 myself) that this was not done on an actual NES console. (Algorithm 2003)
>
> Does it seem odd to anyone else that this video is encoded in wmv? I didn't think Microsoft had a big presence over there. Wouldn't it be easier to encode it as a avi? (cletus 2003)
>
> . . . he did it frame by frame on an emulator and it took two years to complete. Sorta like putting a cartoon together. (Tremmie 2003)
>
> Oh, after examining the [emulator] file closer, I have realized that Famtasia allows you to save state in the middle of a movie and rerecord from this state. Thus, the 11 minute video was actually interrupted and restarted over 40,000 times... move

> than the number of frames in the movie! Also, apparently the guy took a couple years to do it, according to his website. Thus, while no hacks were used, it was far, far from being 'real.' (MEGAß¥TE 2003)

> Doesn't seem quite so impressive, now :/ (Axyon 2003)

Although there was initial confusion among the global audience over what exactly they were watching, the small green links at the end of the video led to two Japanese websites, authored by Morimoto, that explained in detail the process of making the video—the inaugural tool-assisted speedrun.[18]

The first person to carry out a full investigation of Morimoto's work outside of Japan was Joel "Bisqwit" Yliluoma, the Finnish software engineer and computer hobbyist who would go on to found TASVideos.org in 2006. TASVideos is currently the largest community dedicated to making and publishing tool-assisted speedruns. Using tools, the community at TASVideos claim to "overcome human limitations to complete games with extremely high precision . . . [to] tear through games at seemingly impossible speeds. The end result of this process is simply a series of key-presses which may be performed on the original hardware" (TASVideos 2014). By the second week of December 2003, Yliluoma had translated a rough version of Morimoto's documentation and produced his own website, "Bisqwit's NES bittorrent video downloads" (later known simply as NESvideos), which attempted to dispel rumors and popularize Morimoto's methods by detailing exactly how moSMB3.wmv was made (Yliluoma 2004).[19] According to Morimoto's documentation, moSMB3.wmv was not an inimitable, real-time performance of *Super Mario Bros. 3* on the NES, but a carefully constructed sequence of serial inputs planned in advanced, manipulated during production, and executed according to the affordances of NES emulators for the personal computer. Morimoto's .WMV was not a recording of real-time, human play but visual evidence of another kind of play altogether: an .FMV, or Famtasia Movie Capture file, detailing a linear sequence of inputs which could be replayed and edited in the NES emulator, Famtasia, named after the Japanese Family Computer or Famicom.

In computing, an emulator is a piece of hardware or software that implements the functions and operations of another piece of hardware or software. As Nathan Altice (2011) nicely summarizes

> Console emulation mimics a target platform on another, typically more powerful, platform, ideally permitting users to play game software with the closest approximation to the original experience as possible. Accuracy is a key constraint and never perfect. Emulation is not solely a matter of replicating the target console's CPU, but also any additional co-processors, input/output devices, lower level instruction sets, and so on. The NES had dedicated Picture and Audio Processing Units (PPU and APU) in addition to its 6502-based CPU.

Released by nori and taka2 in 1999, Famtasia attempts to recreate the operations of Nintendo's first videogame platform on the personal computer. Ian Bogost and Nick Montfort define "platform" as "an abstraction, a particular standard or specification before any particular implementation of it" and, like the NES or Famicom, Famtasia supports a wide array of software (Bogost and Montfort 2009, p. 2). Whereas the operations of the original system were constrained by its CPU, PPU, and APU (which were, in turn, constrained mostly by money), emulators like Famtasia support additional features like save states, slow down, instant replay, and cutting/pasting—functions which allow players to access, rearrange, re-record, and write the units of serial communication that structure the interface between controller and game. No longer bound to the temporality of the physical platform, Famtasia allows for multiple approaches to playing the serial interface out of order and out of time. Although the player can still steer Mario with a controller (or keyboard), the emulator also allows for play at the level of bit-wise manipulation of the numbers.

Morimoto's .FMV file begins with a 144-byte header that Famtasia identifies based on a simple, four-byte file extension: "46 4D 56 1A." Each cluster of hexadecimal characters represents a byte of data. Unlike binary notation in which only two digits—0 and 1—are used to signify arrangements of bits, hexadecimal notation uses *sixteen* characters: 0 through F (see Figure 4). Like most file headers, the first four bytes of Morimoto's movie declares the file extension "FMV" followed by an escape character interpreted as "/x1a." The remainder of the header contains metadata such as the title ("Morimoto's SMB3 speedrun/recorded by Bisqwit"),[20] how the movie was constructed (resets or save states), and the number of total rerecords (40268 times). After the header, beginning at address 0x0090 (i.e., byte 144), every subsequent byte in the .FMV stands in for an instance of serial input. A byte can be described numerically as a series of eight binary digits (e.g., 00110001), three decimal digital (e.g. 049), or two hexidecimal digits (e.g., 31) that stand in for controller input (see Figure 5). The data temporarily "latched" to the 4021 shift register signifies the state of all eight buttons, and Famtasia's movie files store a sequence of these states. 60 inputs per second become 60 bytes per second. From 00 to FF, all 256 possible combinations of controller input can be represented. For example, exactly 9.85 seconds into Morimoto's video, on frame 591, the byte stored at address 0x02E0 (i.e., byte 736) of the the .FMV file is 00100000, which represents pressing the "A" button the controller and, when played back, selects Level 1-1 from the Grass Land map screen of *Super Mario Bros. 3*. After pressing "A" (20 in hex notation) for 5 frames to select the level, Morimoto makes his way through Level 1, running (11) and jumping (31) over goombas and green pipes (see Figure 6).

Binary (Base 2)	Decimal (Base 10)	Hexadecimal (Base 16)
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

Figure 4: This sixteen-digit binary to decimal to hexadecimal conversion chart details half a byte of data.

Button	Binary	Decimal	Hexadecimal
NONE	00000000	0	00
RIGHT	00000001	1	01
LEFT	00000010	2	02
UP	00000100	4	04
DOWN	00001000	8	08
B	00010000	16	10
A	00100000	32	20
SELECT	01000000	64	40
START	10000000	128	80
ALL	11111111	256	FF

Figure 5: This conversion chart illustrates how the eight buttons of an NES controller are represented as two-digit hexadecimal numbers in Famtasia’s .FMV file.

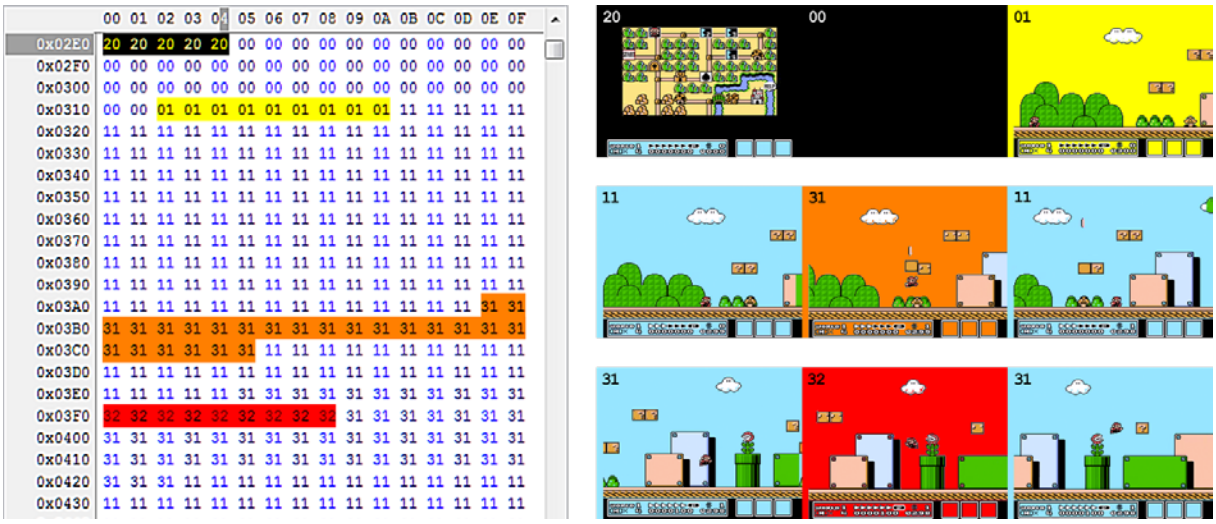

Figure 6: A brief comparison of the hexadecimal representation of Morimoto's .FMV to the visualization of his .WMV reveals a synchronic serial interface—a serial database detailing every button press.

On the original platform, the temporality of controller input is synchronized with the speed at which the NES's Picture Processing Unit (PPU) can update 262 scanlines on a CRT screen. Because the PPU interfaces with CRTs about 60 times a second, the CPU also samples the 4021 about 60 times a second. In the same way a sequence of cinematic stills rolling from reel to reel in a movie projector produce a form of diachronic, industrial seriality, the stream of bit-wise data sent from the 4021 to the Nintendo Entertainment System is an example of the accelerated temporality of digital seriality. However, once the serialized bits sent from controller to console can be represented in the bytes of Famtasia's "movie" files, the diachronic temporality of serial interfacing is put on pause. Rather than real-time streaming, the serial interface is collected and spatially distributed, articulating previously out of reach microgestures in a synchronic, serial database. Like a film reel that has been linearly laid out for editing, Famtasia's .FMV files store every frame of input and can be manipulated by hand in the non-linear interface of a hexadecimal editor. Rather than the serial operations of a time-based movie, it is a manipulable movie file. Tool-assisted speedrunning is not a movie in the sense of a frame-by-frame animation of Mario's sprite within the Mushroom Kingdom, but simply the record of a series of inputs which, when replayed, drive a new instance of the game. Crucially, this kind of play depends on a deterministic relationship between input and output. As Cosmo Wright (2014) states curtly, "[a] game is input->output. Repeat." On videogame platforms like the Nintendo Entertainment System, a series of button presses performed at the same place and at the same time in the same game will always yield the same output. Cycling timers and random variables stored within the system's RAM are reinitialized upon reset so rebooting the game not only restarts the various software routines and processes, but also starts them from the same predictable state. Timed button presses not only determine Mario's movement but, by extension, the value of every single variable in the NES's CPU. As long as the temporal relation between input and output remains consistent, enemies will appear and act predictably and physics will adhere to deterministic patterns. Importantly, slowing down the speed of the CPU and serial input in tandem does not change the mechanics of the game, just their duration. Twitch-based platform games like Super

Mario Bros. become turn-based puzzle games as tool-assisted speedrunners like Morimoto consider the best strategy frame-by-frame by playing the serial interface.

Playing the Serial Interface

The NES-4021 shift register, Morimoto's moSMB3.wmv viral video, and the larger practice of tool-assisted speedrunning provide examples of playing the times and scales constitutive of what Denson and Jahn-Sudmann (2013, p. 13) call "serial interfacing" and "collective serialization." Whether in the context of literature, comics, film, or videogames, discussions of seriality in digital media often overlook the underlying processes of sampling, sending, and storing sequences of data over a single channel. Serial communication, however, is the durational substrate that ultimately governs all forms of digital seriality. From the intra-ludic levels and worlds to the inter-ludic series and sequels to the para-ludic transmedia of convergence culture, modes of seriality are contingent on these atomistic forms of serial communication that network computational media. Although both human and nonhuman players are oblivious to these underlying serial operations—what Denson and Jahn-Sudmann (2013, p. 15) call "blindness to computational temporality"—these forms of serial interfacing nevertheless structure the phenomenal, affective, cognitive experience of play within the collective serialization of consumer culture. While serial communication is the medium through which videogame play occurs, metagaming practices like tool-assisted speedrunning do not simply play videogames but attempt to play the serial interface itself.

Understanding the industrial design, electrical engineering, and computational logic of a given process or platform (via tool-assisted speedrunning) does not necessarily provide conscious access to the alien territories and alienating effects of digital seriality. However, playing the serial interface both dramatizes the difference between the duration of human experience and that of videogame consoles like the Nintendo Entertainment System and offers a possible strategy for intervening in the operations of serial media. Bogost (2013, p. 10), for his part, acknowledges that "[a]s operators or engineers, we may be able to describe how such objects and assemblages *work*. But what do they *experience?*" (emphasis original). Similarly, Hayles (2012, p. 86) suggests, "there can be no account of how duration is experienced by objects." On the other hand, in his forthcoming book, *Feed Forward: On the "Future" of 21st Century Media,* Mark Hansen (forthcoming, pp. 24-25) suggests it is possible to gain "digital insight" by "strategically deploying technical intervention to modulate the inaccessible operational present of sensibility." Hansen (forthcoming, p. 43) calls for "*a supplementary layer of mediation* between technical recording and human experience" and claims "where mediation once named the technical inscription of human experience, today mediation must be redirected to the task of composing relations *between* technical circuits *and* human experience" (*emphasis original*). Tool-assisted speedrunning, as it plays the serial interface and disrupts the expectations of videogame play, offers one possible example of this form of mediation—a supplementary interface between technical circuits and human experience.

Moving from serial communication to playing the serial interface, Morimoto's video also exemplifies how networked culture at the turn of the millennium (a time when modem speeds were measured in Kbps, not Mbps) produced specific forms of serial collectivity. In this sense, tool-assisted speedrunning not only transforms platformers into puzzles, but also converts single-player software designed for the home console into massively multi-player online games as networked communities collaborate to discover new ways to play and compete with each other for the fastest time. Initially misinterpreted as a virtuosic performance, Morimoto's video inspired players to begin performing "real-time attacks" (RTAs) of console games like *Super Mario Bros.* It is no coincidence that Speed Demos Archive—a clearinghouse for collecting *Quake* demos created by Nolan "Radix" Pflug—began accepting real-time attacks of console games performed live by human players around the time Joel Yliluoma created NESvideos (the precursor of TASVideos). While not the first tool-assisted speedrun, Morimoto's video signals the genesis of these two very different metagaming communities who have subsequently changed the way games are played.[21] As one prescient forum poster noted after watching Morimoto's video in 2003, "[i]t seems like this is turning into a new genre of gaming: seeing how fast you can beat the game. And not just running through it fast, literally training to the point that you know where everything in the game is at all times" (CAPiTA 2003). Input 1 then Input 2 then Input 3 in Frame 1. Frame 1 then Frame 2 then Frame 3 in Game 1. Game 1 then Game 2 then Game 3 in Platform 1. Platform 1 then Platform 2 then Platform 3 in a decade of speedrunning the serial interface. From minutes to seconds to milliseconds, both speedrunning and tool-assisted speedrunning asymptotically approach the limits of serial play (see Figure 7).

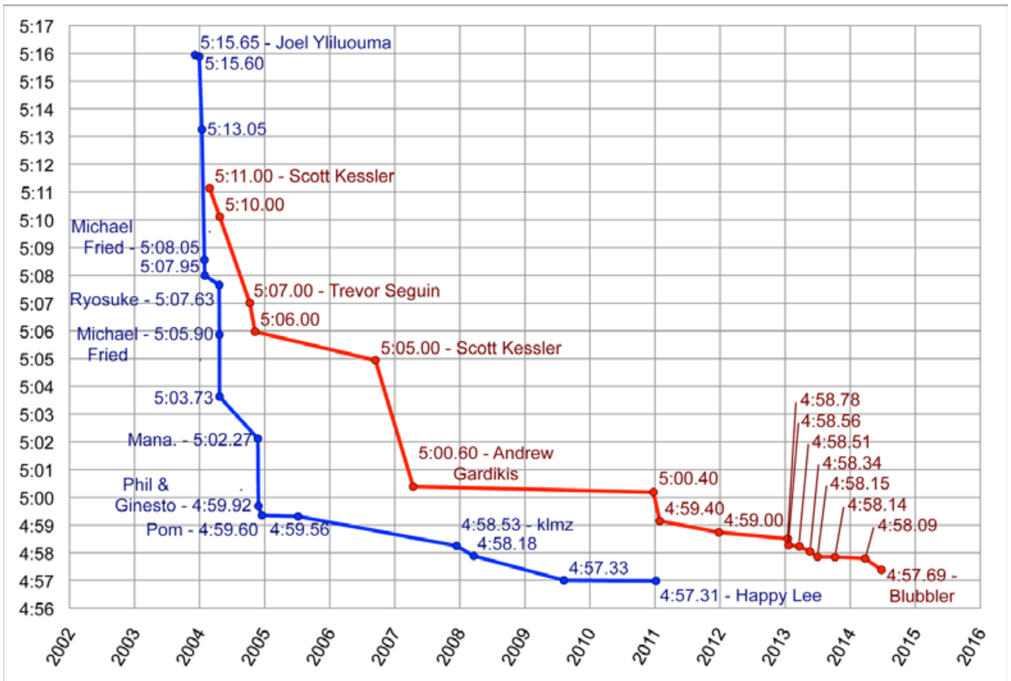

Figure 7. In a little over a decade of speedrunning (red) and tool-assisted speedrunning (blue), players in both communities are approaching the end of games such as Super Mario Bros. In this case, optimized routes and perfectly performed exploits converge on a common limit: 4 minutes and 57 seconds.[22]

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Notes

1 The first long distance telegraph message, "WHAT HATH GOD WROUGHT," was serially transmitted from Samuel Morse at a hearing in the chamber of the Supreme Court in Washington, DC to Albert Vail at the Mount Clair depot in Baltimore and back.

2 In Sartre's Critique of Dialectical Reason, seriality becomes a means of expressing contemporary urban anomie. For Sartre, seriality is the process by which individuals are organized and arranged in relation to one another through a social and technical apparatus. Yet membership within the series goes unacknowledged as each member remains oblivious to their larger systemic relations. Sartre (2004, p. xxviii) contrasts seriality to what he calls "group

formation," the process of becoming conscious of one's relationship to a group identity—which subsequently enables the possibility for political action.

3 Outside of those regions that implement PAL or SECAM encoding standards for color television (e.g., Europe, Africa, Australia, most of Asia, and the eastern half of South America), the Nintendo Entertainment System (NES) operates at about 60 Hz. In Japan and North America, for example, the NES's central processing unit (CPU) runs at 1.789773 MHz. Its picture processing unit (PPU), the Ricoh RP2C02, requires 1 CPU cycle for every 3 "dots" it renders. There are 341 dots in a single scanline and 262 scanlines in a single frame. Therefore if the 1.789773 MHz refresh rate of the CPU is multiplied by 3 PPU cycles then divided by the 341 dots in each of the 262 scanlines, the system can update the screen about 60.0988 times a second or 60.0988 Hz, very close to the NTSC encoding standard. This standard refresh rate limits observable output. Although the states of the buttons can be (and in some cases are) sampled numerous times per frame, this essay assumes a standard of 60 inputs every second for the sake of clarity when describing serial input and the frame rates of NES emulators.

4 Although there are major design differences and minor technical differences between the North American Nintendo Entertainment System (NES) and the original Japanese Famicom (FC), for the purposes of simplicity this essay refers to both systems as the NES.

5 A microsecond (μs) is one millionth of a second.

6 In *How We Think: Digital Media and Contemporary Technogenesis*, N. Katherine Hayles (2012, p. 91) argues that both formal and forensic "[m]ateriality comes into existence […] when attention fuses with physicality to identify and isolate some particular attribute (or attributes) of interest." Importantly, as is the case with shift registers and CPUs, "attention" and "interest" are not necessarily human attributes as a wide variety of mechanisms can observe, identify, and isolate patterns.

7 Although Kirschenbaum focuses on how magnetic inscriptions of data are stored and retrieved on hard disks and drives, his distinction between the formal materiality of bits and the forensic materiality of physical media also applies to the so-called "volatile" memory stored in the semiconductors of RAM or CPU chips. Kirschenbaum (2009, p. 50) notes "even the popular myth that RAM is always absolutely volatile, gone forever at the flip of a switch, proves false; there are at least experimental techniques for recovering data from RAM semiconductor memory."

8 As McKenzie Wark (2007, 023) claims in *Gamer Theory*, "[t]he real violence of gamespace is its dicing of everything analog into the digital, cutting continuums into bits."

9 Unlike the other seven buttons connected to the NES-4021, the state of the "A" button transmits to the NES's CPU directly after latching. The other seven values are shifted forward and relayed only after receiving signal from the "clock" or "pulse" line.

[10] Garfield's definition of metagaming closely mirrors Mark B. N. Hansen's (2006, p. 297) articulation of media as "an environment for life." Following Marshall McLuhan's definition of media as the extensions of man and Bernard Stiegler's concept of epiphylogenesis, in Hansen's essay, "Media Theory," he "conceptualizes the medium as an environment for life: by giving concrete form to 'epiphylogenesis' (the exteriorization of human evolution) . . . media find their most 'originary' function not as artifacts but through their participation in human technogenesis (i.e., our co-evolution with technics)" (2006, p. 297). Similarly, one might argue games do not function as autonomous or abstract sets of rules but require participation or play by players (be they human or nonhuman). If media is an environment for life, then the metagame is an environment for games.

[11] Since eBaum's World incorporated at the end of 2002 the website has been the subject of multiple lawsuits and copyright claims by corporate entities, Internet communities, and individual users. Perhaps the company's best known infringement (aside from Viacom's cease and desist letters targeting an interactive soundboard based on copyrighted clips of Howard Stern) was the misappropriation and watermarking of the "Lindsay Lohan does not change facial expressions" or "Lohan Facial" .GIF originally released on YTMND.com by Derek Lutz (Kushner 2006). "The face that started a war" was finally removed from the site after multiple denial-of-service (DOS) attacks, on-site delivery pranks, and other threats from individual Internet users (Lutz 2005).

[12] The history of media players is remarkably difficult to trace due to the separation between discussions of video content and video players on online forums. Since the Windows Media Video file format was new in 2003, only certain video players included codecs able to interpret .WMVs such as Windows Media Player, RealPlayer, Media Player Classic, and VLC Media Player. Because of the large file size and new format, some users were not able to see Morimoto's *Mario 3*: "::tear:: I couldn't get it to open. I guess too many hits to the page. But just hearing you guys talk about it... wow. That's both impressive and frightening" (mikomonk, 2004).

[13] Like the original *Super Mario Bros.*, movement speed and collision detection in *Super Mario Bros. 3* are based on manipulating Mario's position on the screen. Position is calculated at a "subpixel" scale stored within a single byte of RAM at memory address 0x074D. Despite the fact that a byte can represent 256 discrete values, in *Mario 3*, the byte at 0x074D is incremented by 16, thus subdividing subpixel into sixteenths of a pixel (adelikat et al. 2014). This value is updated sixty times a second, according to the speed of both the Nintendo Entertainment System's PPU and the refresh rate of CRT television screens that comply to the NTSC color encoding standard.

[14] In their "Workers' History of Videogames," Nick Dyer-Witheford and Greig de Peuter (2009, p. 3) frame Mario as a "working-class hero," "an overall-clad, cloth-capped industrial artisan who liberates Princess Toadstool by overcoming a series of bosses."

[15] Bored while on exchange at the University of Central Arkansas in 1999, Hiroyuki Nishimura built a text-based bulletin board with a twist: anonymity. Over the next

decade, 2channel became one of the most popular websites in Japan and, in 2006, was followed by Nishimura's Nico Nico Douga, a video portal (originally a Japanese frontend to YouTube) that allowed users to anonymously overlay comments on top of video (Katayama 2008). 2channel, abbreviated as 2ch, is a subtle reference to radio frequency modulators—a standard video and audio interface between videogame consoles like the Famicom and channel 2 of most Japanese televisions.

16 The spelling, punctuation, and typography in this passage and all subsequent quotations from online forums have been transcribed exactly as they were found.

17 In "Race and/as Technology" Wendy Chun (2012, p. 38) asks, "[t]o what degree are race and technology intertwined? To what extent can race be considered a technology and mode of mediatization, that is, not only a mechanism, but also a practical or industrial art?" In this particular case, the comments of the posters—a mixture of aversion and envy—conflate the machinic apparatus and the objectified, racialized body of the imagined Japanese player on to which the posters project their fantasies about both the content and production of Morimoto's video. The "tool-assisted speedrun" becomes a "race-assisted speedrun" as race itself functions as a technology through which forum posters interface with Morimoto's playthrough of *Super Mario Bros. 3.*

18 Although Morimoto's *Super Mario Bros. 3* video was a popular and widespread example of tool-assisted speedrunning, similar techniques had been used to play both *Doom* (1993) and earlier *Super Mario Bros.* titles. As the founder of TASVideos.org, Joel "Bisqwit" Yliluoma, notes in a 2005 interview, "[w]hile Morimoto's movie was the igniter for the western world to start making tool-assisted emulator movies using the feature called 're-recording', Morimoto's movie wasn't the first of its kind. According to my knowledge, another Japanese person called Tokushin made also a *Super Mario Bros 3* movie in 2001, and yet another Japanese person called Yy made a tool-assisted *Super Mario Bros* movie in 2000. . . . the exact origin of tool-assisted speedruns (emulator or not) is not known, [but] it's clear that it was Morimoto's movie in November 2003 that made the phenomenon world-wide famous" (Yliluoma 2005). Although the early history of tool-assisted speedruns of PC games in the form of "speed demos" is well documented in the work of Henry Lowood and James Newman, Morimoto's video represents a major turning point in the history of the practice as applied to console games.

19 Yliluoma also archived Morimoto's previous projects including speedruns of *Rockman* (1987), *Rockman 2* (1988), *Youkai Douchuuki* (1988), *Hi no Tori Hououhen: Gaou no Bouken* (1987), *Atlantis no Nazo* (1986), reproducing and re-rendering Morimoto's work as high-quality .AVIs available via bittorrent.

20 Since Morimoto's original movie file was created before TASVideos.org was established, it was reproduced and republished by Yliluoma for archival purposes in the fall of 2006.

21 At Awesome Games Done Quick 2014, a week-long charity event that raised over a million dollars for Médecins Sans Frontières, members of speedrunning

community were joined for the first time by tool-assisted speedrunners who demonstrated their metagaming practice live and on physical hardware by electrically manipulating the NES-4021 through a custom controller. Automated controllers, colloquially referred to as "NESbots," are able to play the serial interface in real-time, verifying that input designed for digital emulators like Famtasia can reliably reproduce the output patterns of tool-assisted speedruns on original hardware when synced with the speed of the Nintendo Entertainment System and translated into electrical currents running through the NES-4021 shift register.

22 Because of a discrepancy in standard timing between the tool-assisted speedrunning community on TASVideos.org and the speedrunning community on SpeedDemosArchive.com, these records appear closer than they actually are. In general, speedrunners begin their timers when they first gain control of the game (i.e., at the beginning of Level 1-1 in *Super Mario Bros.*) whereas tool-assisted speedrunners begin timing when the system is turned on. If the tool-assisted speedruns (blue) were retimed according to RTA standards (red), they would each be approximately 3.27 seconds faster.