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Playing Nintendo Without an Actual Nintendo: Video Game Emulation on a Laptop

This paper scrutinizes the act of emulation as a preservation tool and a possible solution for impending format obsolescence and hardware failure in the video gaming industry. Rather than looking at the preservation problems exclusive to one particular title, I will examine the issues that arise when trying to recreate a certain type of console gaming experience on a laptop—specifically, the emulation of the original U.S. Nintendo Entertainment System (NES) and its 8-bit cartridge games on a MacBook Pro. This study will focus on "Nestopia," a desktop emulator, not a flash-based simulation or other Internet emulation of NES games.

Why emulate at all? First and foremost, Nintendo stopped manufacturing the NES console in 1995 and does not sell any retail games for the system anymore. Though the NES sold more than 60 million units,[1] Nintendo no longer offers support or repairs for the system, and it is only a matter of time before consoles around the world burn out and parts become more and more scarce. Nintendo Co. also seems much more concerned with innovation and developing new systems—and rereleasing old games on these new systems—than it does with maintaining its original hardware and software. This story is not a new one.

Additionally, changes in television standards have already affected (and will continue to affect) the functioning of those still-working NES consoles. Notably, the rise

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[1] http://www.nintendo.com/corp/history.jsp

of LCD and plasma flatscreen televisions over CRTs led to the demise of the NES Zapper light gun, one of the most popular peripherals, and other such devices that rely on light and the CRT monitor in order to function. Similarly, the RCA connectors needed to hook the console into a television are quickly going out of fashion.

There is also the nostalgia factor, which becomes immediately apparent just looking around. I saw a lady on the subway with an iPhone cover that looked like a classic NES controller. My brother has a t-shirt depicting the "blood code" from *Mortal Kombat* (ABACABB, for the record). My friend in Buffalo expressed her desire to play *Mario Kart* with me and then called the character Toad. I told her my Nintendo 64 still works so the next time she visits we'll do it (and sadly decided I would play as Princess Peach). People love these old games and still want to play them, though the degree to which "authentic" play matters varies wildly among gamers.

At the same time, emulation also takes up significantly less storage space. An external hard drive the size of the NES console itself could hold emulator software and every title Nintendo ever produced (on the NES as well as later systems) in ROM image[2] form. Most emulators are only a few MB in size and even the most complicated NES ROM is typically under 1MB. My parents could finally get rid of the four enormous plastic storage boxes containing our Atari, NES, Sega Genesis, and N64 consoles, as well as the accompanying cartridges, controllers, cords, manuals, and walkthroughs that have been taking up space in their garage since the mid-1990s. (Not that my brother and I would let them, but the possibility remains.) Obviously, a museum or other repository pressed for space could do likewise.

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[2] Read-only memory: the computer file containing the game data that has been hacked from memory chips in the NES cartridges or "Game Paks."

The Nestopia emulator uses the Macintosh Emulator Port Shell, developed by Richard F. Bannister, which is a direct port of the original Nestopia developed by Martin Freij for Windows. Nestopia version 1.4.1 (and version 2.3 of the shell) for the Mac was released on September 27, 2008[3]. The program requires Mac OS X 10.4 or later, a minimum of a 600MHz for full speed, and a video card with at least 32MB of VRAM (the MacBook in question is running OS 10.5.8 with a 2.4 GHz Intel Core 2 Duo processor and 256MB of VRAM). The software "uses highly optimized cycle exact emulation, allowing it to run titles that rely on precise timing, many of which break under inferior emulators."[4]

Features include support for 201 different mappers, "covering just about every known NES title,"[5] and certainly every title I tested. Nestopia can also emulate the Famicom Disk System—the earlier Japanese version of the NES—though I had no use for this and was unaware of the Famicom console until conducting research for this project. It also supports the five most common sound chips and can open UNIF format NES games and NSF sound files: "In addition to the standard NES pAPU, Nestopia supports six extra sound chips - Famicom Disk System, Konami VRC6, Konami VRC7, Namcot 106, Nintendo MMC5, and Sunsoft FME-07."[6] Indeed, I could detect no problems or abnormalities with the music or sound effects in any of the games I played. A note on Nestopia's speed, which is sometimes criticized as being slower than other NES emulators:

Nestopia has been designed to be as accurate as possible. All The

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[3] From the "About Nestopia" documentation bundled with the software, downloaded from http://www.bannister.org/software/nestopia.htm on 11 February 2011.
[4] http://www.bannister.org/software/nestopia.htm
[5] "About Nestopia"
[6] "About Nestopia"

different components are synchronized "as needed" on a clock cycle level, basically meaning that the PPU and pAPU update themselves only if an instruction is going to change the way the PPU render pixels or the pAPU generates sound or else they simply just wait until the end of the frame and then carry on. They all use the "master clock" as a cycle counter base which eliminates the need for decimals altogether. With this method many games that rely on perfect timing work flawlessly on Nestopia (Mach Rider, Slalom, Marble Madness etc).

This does mean that Nestopia is quite a lot slower than other NES emulators (which use scanline or tile based rendering). However, if you have an 800MHz G4 or faster, Nestopia is for you.[7]

Nestopia is also configured to play PAL games at 50 frames per second.

An option specific to gameplay is the ability to enter "Game Genie" codes. Game Genie is a peripheral device that attaches to a game cartridge and allows a user to enter codes—almost exclusively cheats—that modify game data. Another feature, downloaded separately, is an emulator enhancer that allows for the use of a joystick as well as networked play. I did not install this enhancer, however, as I never used a joystick (the NES "Advantage") with the original NES, nor do I have a USB joystick. Similarly, I did not test any games with networking capabilities.

Nestopia seems to be able to reproduce the software aspects of NES gameplay faithfully and successfully. A few of the side-scrolling games occasionally exhibit some visible screen or pixel lag and dropout not found in the original game. In one case this was as extreme as a full screen roll, almost like a VHS tracking error. Whether this was due to faulty emulation or a poorly designed ROM is unclear, though it seems more likely that this is the fault of the ROM. Overall the quality and speed of the video was extremely good and functioned just as well as the original NES.

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[7] "About Nestopia"

There were some color discrepancies between Nestopia and RockNES, another Nintendo emulator, when viewing the same ROM image side by side. The colors were brighter and slightly more yellow when viewed in RockNES. This issue is harder to gauge, though, as there would have been color variations because of differences in monitor calibrations between television sets, and it is difficult to know what the "true" colors of a video game are supposed to be (i.e. there are no bars or tone to match to). The point is worth taking into consideration, however, as game designers and artists might have specific ideas about display.

For the most part the problematic dependencies were the external ones, especially the controllers (or rather, lack thereof). Obviously, the more peripheral devices there are, the more issues an archivist must take into consideration and the more potential problems may arise; at the same time, directly parallel peripheral devices exist with original NES console already, so these considerations should not provide additional tasks for the archivist (only slightly modified ones).

Nestopia's default keyboard configuration defines the arrow keys on the right hand side of the keyboard as the directional pad and the option and shift keys as A and B. This is the opposite of the standard Nintendo controller, which has the D-pad on the left and the AB buttons on the right. Though the left-right issue can easily be solved using the keyboard map in the preferences, the larger and more serious problem is that of not being able to use your thumbs. Frankly, I had no idea how difficult it is to play most Nintendo games without my thumbs.

There are a few games that require less manual dexterity, or which separate left/right/up/down movements from AB actions somewhat (*Tetris*, *Dr. Mario*, the tile

sliding game in *Bart vs. the World*, and other such puzzle games), but most Nintendo games require the simultaneous use and/or combination of both directional arrows and AB button mashing. Maybe my fingers are just less coordinated than my thumbs, but both running (holding B plus right) and jumping in a particular direction (A plus any direction) became extremely difficult, to the point at which I was dying on levels of *Super Mario Bros. 3* that I had never died on before in all my years of living and gaming on this planet. And let's not even talk about flying (which involves running into a jump). Even placing the AB buttons on the far right side of the keyboard and then attempting to hold the underside of the laptop like a classic controller does not work (at least not with my small lady hands on my enormous 15" long base with extended speaker area).

Furthermore, two player games (in which both players are engaged simultaneously, as opposed to taking turns), or games that require both controllers in order to enter a cheat code (such as *Q*bert*), are extremely difficult to play on a laptop. The MacBook Pro does not have a full keyboard with right hand number pad, making it necessary to reconfigure the keyboard in the application preferences in order to place the second player controls on the board. While the keyboard is fully configurable and customizable, allowing you to map any combination of keystrokes you desire, it is still difficult for two people (either children or adults) to huddle around a single screen—even a 17" monitor, like I have.

Cradling the classic NES controller in order to use the thumbs on both the D-pad and AB buttons seems to be a required user action for the successful completion of most game levels in the majority of NES games—especially those in the *Mario Bros.* canon and any of the side-scroller genre—and one which cannot be duplicated using just a

computer. That being said, there are a variety of USB and wireless controllers available to solve this very problem, many of which Nestopia in fact supports. USB controllers seem to fall into three general categories:

• Using an original NES controller plugged into a USB adapter[8]

• Modifying an original controller (i.e. splicing off the power plug and soldering on a USB plug)[9]

• Purchasing a new controller built specifically with a USB plug[10]

There are also a variety of controllers manufactured for other gaming systems, many of them wireless, which the emulator will recognize. The standard Nintendo Wii Remote is such an example, though it is smaller and thinner than the NES controller, and has to be held sideways in order to replicate the NES button configuration. As briefly mentioned at the beginning of this paper, the NES Zapper light gun does not work without a CRT monitor. However, Nestopia does in fact support the Zapper light gun—via mouse. I would imagine that at some point in the near future an infrared or laser-positioning gun like those used with modern LCD displays will be modified for emulation and the software will be upgraded accordingly (if this is not already in the works).

The reviews of these different types of controllers contain comments that delve much deeper than just "Does the controller work on my computer?" even going so far as to describe the texture of the plastic and the weight of the controller, especially as compared to "the one you remember from childhood." Most if not all reviewers want controllers with real rubber Start and Select buttons, showing a demand for accuracy over

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[8] One of many examples currently for sale: http://www.amazon.com/Retrolink-Nintendo-NES-USB-Adapter-Mac/dp/B000PDOTXG

[9] How-to instructions: http://www.joystiq.com/2004/09/07/how-to-make-a-nintendo-controller-into-a-pc-joystick/

[10] Again, one of several examples of varying price and quality: http://www.amazon.com/Classic-USB-NES-Controller-PC/dp/B002YVD3KM/ref=sr_1_2?s=videogames&ie=UTF8&qid=1303382542&sr=1-2

mere functionality. Is this simply fanboy whining and a chance for vendors to increase the price of their third party wares based on a false sense of nostalgia? In some ways yes, but in other ways the weight and feel of the controller taps into muscle memory and affects your ability to play the game. In the end it all comes down to user preference. Some gamers will choose the wireless controller because it's easier and they can sit farther away from the screen on the couch, while others will choose the wired, more "authentic" version because they want to recapture the experience of mom walking in and yanking the controller cord out of the socket to get them to go to bed. If you gave me a cheap plastic knockoff controller I would take it, but I would still probably buy a modified original and use the fake one for the second player.

This ultimately feeds into questions concerning availability vs. authenticity and the sense of "Well at least I can play some form of the game—at least it works" vs. "But that's not the way it really was—that's not the way it's supposed to be." I have yet to come across a wireless controller that looks like the original NES controller, though I'm sure one probably exists somewhere. At the same time, it seems like gamers who are willing to go through the trouble of getting a controller made out of the same plastic, of the same weight, are going to want the cord too. Everyone else will just use their Wii Remote. Even though this is emulation, even though this isn't "really" playing a Nintendo Entertainment System, the developers of Nestopia and the peripheral products have gone through an enormous amount of trouble to make the experience as authentic as possible. Nestopia can even "simulate NTSC video artifacts," making your computer screen look like a crappy old CRT TV with blur and color bleed in all the right places. This is ultimately good news for preservation, because not only will there be more

"experts" who "know" what games are supposed to look and feel like, but also because there will be more and better options to choose from in terms of both hardware and software workarounds. This is still an active field and we can talk to programmers and tell them what options we want, while also surfing Craigslist for cheap console parts.

On the other hand, the Nestopia emulator itself does actually offer some abilities not found in the original NES. The "freeze game state" option lets you save your game at any point, even in the middle of a level. You can quit the program and start it up again after dinner, rather than pausing the game at the beginning of a level and then leaving for an hour. This common practice was good for neither the life of the game system nor your television screen, but before the Playstation introduced rewritable memory on removable media and load times, there was not a true save function. While Nestopia maintains an environment nearly identical to the NES one I used in 1994, it offers a few modern conveniences that I can implement if I so choose.

While the NES console has been emulated with a high degree of success and reliability, the ROMs are actually what pose the most potential problems for nostalgia gamers (and, presumably, archivists). These are not technical problems with playback of game data so much as legal problems with the IP holders. The most serious threat to ROMs or other duplicated games is copyright infringement. Video gaming is such a new medium that even the earliest NES game rights are not set to expire for another 40 or so years. Because downloading ROMs is illegal, there are no standards guiding their creation or distribution, and the quality of the game you play (and the chance that the text is written in Japanese) is largely random and entirely dependent upon who ripped it and where you've found it.

Many gamers attempt to use the DVD archival/backup exception, claiming that since they have already purchased the original NES cartridge, they should be allowed to download (and store and play) backup copies of the same games they already own. However, the backup rule only applies if you are the one digitizing the data off the original cartridge that you purchased; downloading that same information from someone else is still technically illegal[11] (and, of course, there is no guarantee that you will only download ROMs of games that you already own). Nintendo maintains that game copying devices are illegal "based upon [their] function,"[12] but I believe this is wrong. The distribution of copied content is illegal. Simply having a device or using such a device to back up your own games that you have in fact paid for is not illegal. This is Nintendo using scare tactics to discourage piracy. Owning a game-copying device may incriminate a user, but the illegality is based on the intent of that user, not on the nature of the software itself.

The truth of the matter is that game companies like Nintendo love to produce "classic" rereleases and bundle packs, banking on both nostalgia and obsolescence to market these, which naturally becomes harder when consumers still have access to the "original," in whatever form. Game companies hate emulation, for obvious reasons, unless they are the ones doing it and would much rather your NES from '92 break, forcing you to re-buy all the Mario Bros. games bundled for the "Virtual Console" on your new Wii. You may think you're getting a deal when you buy a cartridge with 372 classic games for the price of one new one, but how many of those did you pay for back

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[11] If you are from Nintendo and you are reading this paper on the Internet, I made all the ROMs referred to in this paper myself. Did not download any of them, no sir.

[12] http://www.nintendo.com/corp/legal.jsp#roms

when they were new? Nintendo wants to continue exploiting the content they have created for as long as possible—which is well within their rights to do—but they are wholly unconcerned with issues such as format obsolescence precisely because they are still building new consoles to take advantage of outmoded technologies, as well as creating "new" content from this old content that they still legally own. They intend to continue creating new formats and then re-issuing these old games on them for as long as they can renew their copyrights, which is essentially a form of migration, though a greedy, corporate form of migration. All that being said, playing *Bomberman* on the Wii is not the same as on the NES, and the fact that there are so many NES emulators in existence demonstrates the desire of gamers to recapture that "classic" experience.

It seems almost like the history of these companies and the development work of the game designers and artists are more at risk of being lost than either software or hardware. There are a lot of options for saving the media itself; instead we should be saving the surrounding context. How many articles are there about Atari tossing entire departments' file cabinets into dumpsters and selling locked desks for $15 at auction? How many original boxes and owners' manuals did we lose or throw away because we didn't care about them, as compared to the number of Game Paks? We've got the media covered for at least a few more years. Find the documentation now while there are still 40 working NES consoles for sale up on NYC Craigslist.