Dedicated to Jason Scott, aka @textfiles

"POOR BLACK SQUARES": AFTERIMAGES OF THE FLOPPY DISK

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Residual Media

It was an obscure government report, but it contained a tidbit that went viral immediately: in May, 2016, a white paper released by the U.S. Government Accountability Office on the need for federal agencies to address aging legacy systems noted (more or less in passing) that elements of the nuclear command and control system for Minuteman missiles still relied on a forty-year-old IBM Series/1 computer serviced by 8-inch floppy disks. "Introduced in the 1970s," the author explained, "the 8-inch floppy disk is a disk-based storage medium that holds 80 kilobytes of data. In comparison, a single modern flash drive can contain the equivalent of more than 3.2 million floppy disks." The report also included a helpful illustration depicting one of the matte black square-shaped disks with a donut hole in the middle alongside its paper slip case.[1]

The Internet loved it. The juxtaposition of floppy (*floppy!*) disks with nuclear-tipped ICBMs seemed to encompass everything that was absurd about both government bureaucracy and Cold War strategic thinking—*WarGames* (1983), *Dr. Strangelove* (1964), and *Brazil* (1985), all at once.[2] It was left to the *Washington Post* to explain that the military logic (such as it was) was that the IBM Series/1 was isolated from any networked threat and the air-gap bridged by floppies was a security feature, not a bug. (The *Post* also reported that the system was due to be overhauled and replaced in 2017.)[3] Regardless, the entertainment value of this news item—feeding the Internet's insatiable appetite for irony and oddity—underscores the extent to which the floppy disk has lodged itself in the memory of a generation weaned on the totems and paraphernalia of early home computing. It also suggests other contradictions worth our notice: that floppies are self-evidently obsolete but still stubbornly useful and useable, much like a typewriter or landline telephone in certain circumstances; that they are ancient and obscure technology—such that the GAO report's author felt obliged to explain the most

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basic facts about them—but yet everyone devouring the story online knew exactly what a floppy disk was, and so the delighted (if slightly queasy) reaction.

The floppy disk is thus an exemplar of what Charles R. Acland and others, after Raymond Williams, have asked us to call residual media, a formulation they employ as an alternative to the relentless presentism of so-called "new" media. Residual media, by contrast, reveal the persistent medial continuities between and across different historical moments, and they trouble our standard progressive narratives of technological advancement.[4] My locution of the afterimage in the title of this essay is meant to evoke this same lingering quality, but it has two additional valences as well: the first is to account for the iconography of the floppy in popular visual culture; the second is to direct us to a specific set of technical preservation practices for floppy disks, a topic which this essay treats in some detail. The floppy's afterimage is not just the fossilized remains of a dead medium from the Jurassic era of computing; it is—quite literally as we will see—the means by which the programs and data once stored on floppies are reanimated.

A floppy's virtual afterimage presides over the very window in which I write this, a tiny thumbnail icon in the privileged top left corner of the screen that initiates the Save command—itself an increasingly residual function, as most productivity software nowadays AutoSaves by default.[5] Yet given their status as residual media, floppies are also non-virtual remainders taking up space—a lot of us still have a shoebox or two of them tucked away somewhere. As they pile up, the consequences can be deadpan amusing: "Give us a sec. We goin through floppy disks", tweeted the Roots's Questlove, with an accompanying Instagram photo.[6] In this they can function as what museum professionals term *numinous objects*, seemingly ordinary everyday things that take on an aura because of the personage they have been associated with. Derrida anticipated as much: "Some particular draft that was prepared or printed on some particular software, or some particular disk that stores a stage of a work in progress—these are the kinds of things that will be fetishized in the future."[7] Sure enough, a couple of years before his death, a fan fished a dozen or so floppy disks belonging to John Updike from the author's curbside trash and posted pictures on the Internet.[8] When Prince died, Anil Dash tweeted a photo of a 3½-inch diskette emblazoned with the famous "Love Symbol" the artist had begun using in 1993; the diskette contained the font for the glyph, one of many that had been prepared and mailed to publishers and news outlets so it could properly be rendered in print.[9] The disk becomes a totem of a particular individual.

Floppies have proven generative in other ways too. Writers are often given to reminiscing about their early computer experiences; for example Karl Ove Knausgård who, in Book 5 of his autobiographical serial *My Struggle* recalls the "green luminous futuristic letters" on his monitor that are then "saved onto the thin little disk and … brought back to life with one tap of a finger, like the seeds that had been trapped in ice for hundreds of years and then, under certain conditions, could suddenly reveal what they had contained all this time, and germinate and blossom."[10] Other kinds of artists have also found uses for the disks' distinctive square afterimage. The photographer Jim

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Golden, for example, uses the regular geometry and enamel colors of floppies to compose striking visual collages.[11] London-based artist Nick Gentry has similarly used them as a patterning element in his work, employing mosaic-like arrangements of diskettes to create portraits.[12] YouTube can be mined for homegrown videos wherein the grinding and gnashing of old floppy disk drives is orchestrated to reproduce the *Star Wars* theme or similar.[13] On the Cartoon Network's popular *The Regular Show* (2010–2017), Floppy Disk joins 8-Track, Betamax, and Reel-to-Reel to form an animated quartet known as the Guardians of Obsolete Formats. Floppies have inspired pillows, coasters, notebooks, and coffee tables (complete with drawers, thus turning the table back into a literal storage device (see Figure 21.1)).[14] There is a floppy emoji and there are floppy tattoos (see Figure 21.2). It might be harmless hipster nostalgia, but such persistence should not surprise us: floppy disks have been willfully defying their own obsolescence ever since that wagging, flexible descriptor was applied to their most widely distributed form factor, the patently inflexible hard plastic 3½-inch disks that had begun appearing by the mid-1980s, only to be superseded themselves by what were termed "hard" drives in contrast.

Figure 21.1
The Floppy Table. (Source: www.floppytable.com/)

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Figure 21.2
Floppy tattooed on the right forearm of Trevor Owens, a digital preservationist. The tattoo is based on an image included in the Noun Project. Photo by the author.

Hard drives, in fact, historically predated floppies, which were once regarded as the more advanced medium. Hard drive or hard disk technology—itself the successor to a wide variety of exotic storage media, ranging from punched paper tape to mercury delay lines and so-called Williams tubes or cathode-ray tubes to magnetic drums and ringlets, as well as, eventually, magnetic tape—was initially developed by IBM in the 1950s, with a system called the RAMAC 305. Displayed at the 1958 World's Fair, the 1960 Olympic Games, and soon thereafter in glass-walled showrooms belonging to corporate clients including United Airlines, the RAMAC was an industrial refrigerator-sized unit moved with a forklift. Its storage capacity? About 5 megabytes.[15] Floppies only became commercially available in 1971 (again from IBM) in the original 8-inch format; by 1976 Wang Labs had introduced the so-called "minifloppy", smaller at 5¼-inches, less cumbersome, and less expensive. Though the storage capacities of both early formats were dwarfed by a hard disk, their portability and affordability were understood as key advantages in the burgeoning market for home and office computers.Floppies were media that wore their material particulars on their (paper) sleeve, literally: single-sided, double-sided, single density, double density, high density, hard-sectored, soft-sectored—incantatory speech brushing the particulars of magnetic recording technology across the tongue. This was guild speech, and further initiation yielded further mysteries: tracks, sectors, nibbles. (Floppies, in fact, demanded a literal act of initialization in order to be ready for use, one of the first rituals home computer users mastered.) Jerry Pournelle, a science fiction author and correspondent for *BYTE* magazine, devoted

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continual column ink to tracking ongoing changes in the industry: "Shirt-pocket floppies haven't been out long enough; I don't recommend them just yet", he wrote in 1984, meaning the then new-fangled 3½-inch disks. "I believe they (along with hard disks) will eventually replace both 8-inch and 5¼-inch disk drives; but not yet."[16] Pournelle's prognostication proved right: by the time the first integrated systems such as the Apple, Commodore, Kaypro, and Osborne appeared, the 5¼-inch disk had emerged as the preferred option, appreciated for its convenience and relatively capacious 140 KB of storage. But the rigid 3½-inch disks eventually supplanted them as the industry standard. Smaller and more durable, sheathed in a hard plastic carapace and with significantly larger storage potential, it was inevitable.[17] Even then though they were still universally known as floppies, right up until when Sony (the last company to commercially manufacture 3½-inch disks) finally ceased production in 2010.[18]

The floppy disk—with its seemingly self-contradictory geometry, rectilinear rather than circular—furnished the unlikely platform for the first popular digital culture the world had ever known. Floppies were to personal computing what the paperback book was to publishing and mixtapes were to pop music. They made it trivially easy to move material from one computer to another, the classic incarnation of the so-called "sneakernet". Unlike a hard drive, sequestered deep inside the recesses of the machine, a floppy was something you held in your hand. They were visible *and* tangible. (Indeed, the instructions that came with floppies were replete with warnings about which areas of the diskette you could and could not touch.) Even the write-protect mechanisms yielded haptic engagements that quickly became muscle memory, whether applying (and peeling to remove) an adhesive bandage from the diskette's outer envelope or manually thumbing a plastic switch up and down. Meanwhile, a hole-puncher let you double-side the diskette, a second write-protect notch transforming the floppy into a "flippy" disk and thereby doubling your storage capacity (useful when you were eleven years old and a fresh box of floppies was something you had to save your allowance for). And like some talisman out of a Borges story, these strange new objects (suddenly seemingly everywhere) spawned additional new artifacts in their wake—an enormous array of purpose-built containers, boxes, bins, travel packs, albums, flip-books, and carousels were available for home and office, made of plastic, metal, pressboard, and occasionally hand-tooled from real wood. Storage, it turned out, that demanded a goodly amount of storage for itself.

Floppies also quickly came to cohabitate with other media, notably books and magazines. When Microsoft Word was released, a copy of the program was included on a floppy slipped into the November 1983 issue of *PC World*, the first time that particular gimmick—soon to become a staple of companies such as AOL—had been seen in the industry. A year later Robert Pinsky, later to become Poet Laureate of the United States, co-wrote an interactive text adventure called *Mindwheel* (1984) that began as prose fiction you read on the printed page and continued on a floppy disk you plucked from the sleeve at the back of the book and slotted into your Commodore, IBM, or Apple computer.[19] Anticipating an entirely new literary form, the publisher, Brøderbund, trademarked the

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phrase “Electronic Novel”. Libraries, for their part, had to develop new lending policies for the floppies that found their way (Trojan horse-style, inside of the books) into their stacks. Floppies were thus mass media that could be used for promotions and publications, but they were also personal media—you could outfit them with labels and annotations and decorated sleeves (see Figure 21.3). And like the mixtapes that were ubiquitous at about the same time, you could lovingly curate them, loading up an individual diskette with programs, text files, clip art, fonts, or whatever else you wanted to share. We might even say floppies were social (or at least sociable) media.

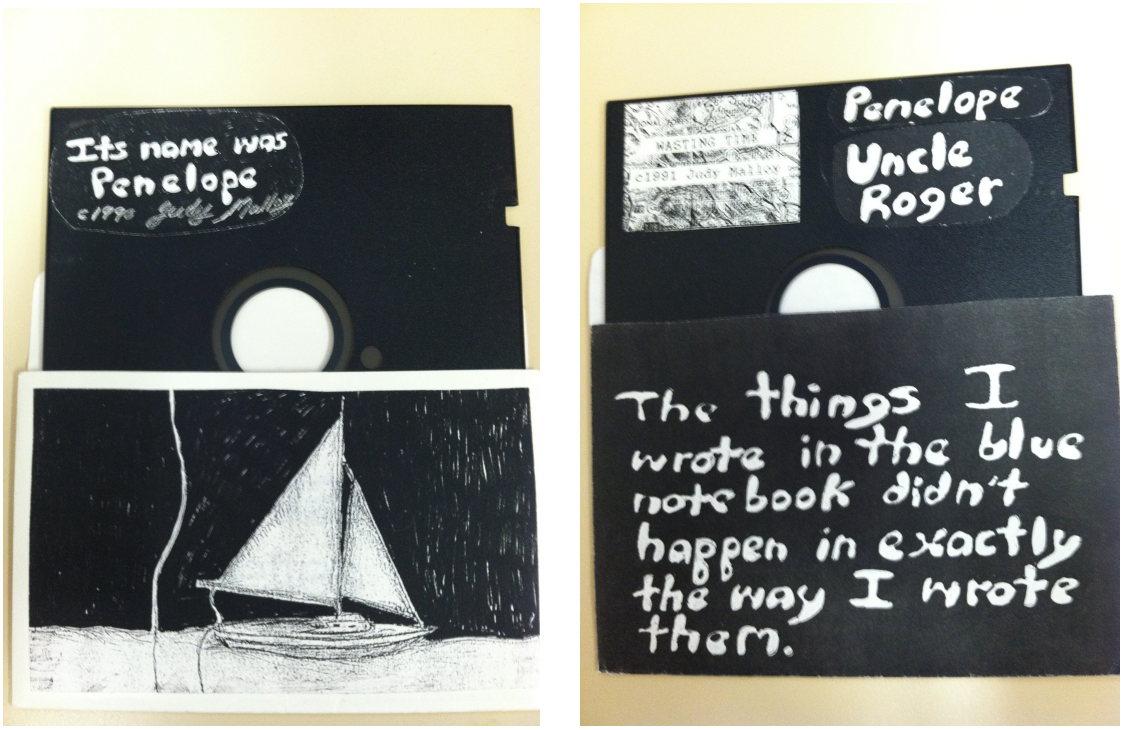

Figure 21.3
5¼-inch floppy disks labeled and decorated by the writer and artist July Malloy. Photos courtesy of Lori Emerson, used with permission.

Because the disks could only hold so much, floppies made the weight and heft of software something felt by nearly every user. It was not uncommon for programs to sprawl across a dozen or more diskettes which, to install, one had to sit and assiduously attend to, swapping them in and out of the drive to load the entire thing (and perish the thought of a read error on the final disk). Even once installed, many programs demanded the regular swapping of floppies, as between a program disk and a data disk, back and forth, again and again. (Two drives on the same system were thus desirable to reduce this need for fumbling.) But perhaps nothing served to demonstrate the curious physicality of software as convincingly as a gag built into Jordan Mechner’s first published game, *Karateka*. Released by Brøderbund for the Apple II in 1984, *Karateka* was a side-scrolling martial

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arts fighting game with unusually good graphics and its own musical score, as well as dramatic, cinematic cut scenes—all of it packed onto a single 140KB floppy, a truly formidable piece of software engineering. The diskette, however, also contained a second copy of the game on its reverse side; and if a player were to accidentally insert it into the drive upside down, the game would obligingly appear on the screen but *also* upside down! In retrospect, it is exactly the sort of thing a puckish young designer (Mechner was just twenty at the time) would do—and it was a programming trick, not an actual consequence of the disk's being inverted. Nonetheless, the effect speaks powerfully to the way in which the medium of the floppy created a tangible sense of connection between how the user handled the disk and what went on inside of the computer, much as playing a record backwards could be exploited to similar ends.

The limited storage capacity of the disks—ranging from 80<th>KB for 8-inch disks in the early 1970s to 140<th>KB for the 5¼-inch to (eventually) 800<th>KB and then more than a megabyte with 3½-disks—their capacity *increasing* even as the physical dimensions shrank owing to advances in magnetic recording—was a palpable constraint, but it also spurred innovation (and a healthy respect for efficiency) in programming. Perhaps the greatest testament to this limitation is the digital artistic practice known as the demoscene. Though seen on a variety of platforms today, the demoscene originated with software pirates who, when cracking a disk (more about this in the next section), took to adding ever more elaborate ruffles and flourishes to the intro screens of hijacked programs as signatures of their work. Because there was often very little space on the disk to spare, these additions demanded complex bags of tricks that evolved into their own form of competition between rival hackers and crackers. The results were virtuoso demonstrations ("demos") of how to maximize dramatic visual and audio effects while minimizing resources such as processor speed, memory, and disk storage through creative coding.[20]

Floppies even had a distinctive aural dimension. Indeed, unlike the smaller sizes that came after them, 8-inch diskettes were kept in continual motion by the drive, creating a background noise that some users found distracting; it was regarded as a drawback. But that familiar grinding crunch could also be expressive: an experienced practitioner could tell a lot from the sound of the drive's churning as it tried to read an unreadable sector. Maybe the disk was caught in a copy protection loop, or maybe it was a bad sector (the underlying media physically damaged); those were both recognizable sounds. The noise made by the drive could also function as an important cue in games, when the sudden sound of the floppy being accessed meant a new level or a new piece of the puzzle was being loaded into RAM memory. Even the time required to read the floppy into memory could prove expressive, the lag contributing to the sense of a journey in a game such as *Oregon Trail* (1985). Less poetically, loading a new level from the floppy gave harried players a chance to flex their fingers and breathe.

The humble, seemingly unadorned floppy disk offers a rich index to the material culture, technical practices, and creative constraints of the personal computing era. Floppies have been continually defined and redefined by their inherent contradictions, ranging from the superficial—that their outer

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shape is in fact square, or that (in time) they grew rigidly inflexible—to the more profound: limited in size and capacity but seemingly endlessly expressive and generative, a storage solution that is undeniably obsolete even as it is still visibly and palpably present. As we will see in the next section, the afterimages of floppies endure in unexpected and even remarkable ways.

Shoebox Stories

Floppies might have been all that, but they could also be the wellspring of considerable frustration and woe. Any disk could fail at any time, and the most basic lesson every home computer user internalized was backing up their work. Backups had to be made early, and often. This applied to your data—your spreadsheet files, say—but it also applied to the programs themselves. Shrink-wrapped software was expensive, and a customer who bought a game or a word processor expected to be able to make backup copies of the program for the day when the original disks failed. (Keep in mind that for systems without a hard drive, the program disks would be in continual use.) There was one problem: if the owner could copy a program disk for backup purposes they could also copy it for other purposes, including passing it along to friends or even selling bootlegs at a discount. Piracy became commonplace, and a generation of users who otherwise might not have imagined themselves especially technically inclined learned their way around disk operating systems and low-level data structures just by trying to dupe a copy of *Miner 2049er* (1982) or *Choplifter* (1982) from a friend.

As a result, software developers waged an ever-intensifying battle with software pirates, employing ever more recondite techniques which sometimes seemed to bend the laws of magnetics to encode data in novel and unpredictable ways. For example, one form of copy protection perfected by a programmer named Roland Gustafsson involved tinkering with the divisions between the different sectors (or cells) of the diskette's internal formatting, so that a standard 140<th>KB floppy could actually be made to hold a couple of dozen extra kilobytes; when some hapless individual attempted to "crack" such a floppy they would find that it—somehow—contained more data than they could save on to a duplicate disk of supposedly the same size.[21] Pirates, for their part, matched each anti-copy scheme with another generation of cracking tools designed to defeat it. Some companies went low-tech, selling software for pennies on the dollar and simply imploring users to buy it rather than copy it; others made programs dependent on access to a manual and (especially for games) other kinds of paraphernalia, so-called "feelies" packaged with the disk itself. (Infocom set the gold standard for this approach with their best-selling interactive fiction titles and their feelies are now collector's items.) By 1992, the problem had become so acute that the Software Publishers Association produced a 9½-minute music video entitled "Don't Copy That Floppy" featuring an extended rap routine of the titular jingle intercut with earnest dialogue between two precocious teens. The performance was unquestionably excruciating; the message, however, was uncompromising: if you keep on copying those floppies then software companies will not make money and programmers (maybe you want to be one yourself some day?) will not get paid; and the industry, like the screen,

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will go dark; game over.[22] (And if that was not enough, the lyrics relentlessly hammered the contention that copying a floppy was not just morally wrong, it was illegal.)

If the battle against illicit copies was once seen as life and death for the software industry, today the ability to successfully copy (migrate) data from obsolescent media is vital to preserving the content stored on them. Despite expectations to the contrary, data on disks from the 1970s and 1980s is often still recoverable by digital conservationists. Nonetheless, the realities of magnetic recording and decomposition can only be staved off for so long; with each year that passes more and more data on those disks decays. As the computer historian and archivist Jason Scott warned on his blog: "Someone has to break it to you, and that person is me. It's over. You waited too long. … With some perseverance and faced against all the odds stacked against you, something might get out of these poor black squares, but I would not count on it."[23]

Transferring or migrating data from floppies is a relatively straightforward procedure for the digital conservationist, at least with 5¼- and 3½-inch formats (8-inch and other sized disks are less common and present greater challenges).[24] Tools and hacks exist for connecting old drives (whether scrounged from eBay or dusted off from the basement) to contemporary systems with hardware bridges; at that point, if the diskette itself is still physically intact and if the data stored on the media has not been compromised, the bits can usually be read from the floppy, yielding what is known as an "image"—a complete virtual surrogate of all the information once stored on the disk. A disk image is not a photograph of a floppy but rather a bit-by-bit copy (sometimes also known as a bitstream) of the source, including partially deleted fragments of old files and other extraneous data (a tool called a hex editor can be used to examine the raw bytes of the image and extract strings of text or other data). Disk image files are thus self-contained digital objects of the same size (80<th>KB, 140<th>KB, 800<th>KB, etc.) as the original media that can circulate (and multiply) as content on our own contemporary systems and networks. Minus the actual material qualities of the diskette—its label and outward appearance—they are true simulacra of those "poor black squares", such that a disk image created under proper circumstances is legally admissible as evidence in a court of law. A more common use to which disk images can be put is to be run with emulation software in order to recreate the experience of some now-vanished program. They are talismanic in that sense, or uncanny, but the process of obtaining one also inculcates an extreme awareness of the mundane array of connections, cables, controllers, hacks, patches, and workarounds required to circumvent the fundamental incompatibility between a media format now some thirty or forty years old and the hardware coming off assembly lines today. As Jonathan Sterne reminds us, the reality of computing is often characterized by precisely such juxtapositions of "old and new" media, with obsolesced devices, defunct and dysfunctional cables and connectors, and spare parts accumulating and commingling.[25]

Some remarkable recoveries from floppies have now come to light. For example, in April 2014, a team of scholars, artists, and engineers based at Carnegie Mellon identified and retrieved digital

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paintings created by Andy Warhol on an Amiga 1000 computer in 1985, stored on 3½-inch floppy disks at the Andy Warhol Museum. After some elaborate intermediary steps, including reverse engineering the proprietary format in which the files were originally created, the previously unseen artworks were released to the public.[26] As befits a find of this magnitude—a dozen new Warhols!—press coverage was extensive. Some six months earlier a similar recovery had taken place at the New York Public Library, which owns Timothy Leary's papers. As one press outlet noted, the "papers" include some 300 floppies, "containing notes on everything from cybersex to cryogenics [and] letters to famous actors and artists."[27] Also among the digital detritus were prototypes of several incomplete video games designed by Leary (one of them based on William Gibson's novel *Neuromancer* (1984)); the games, which had not been accessible for decades, are described as their own quirky, whimsical expression of Leary's worldview.

Both the Warhol and the Leary stories involve (not altogether coincidentally, one might argue) two members of the counterculture born in the same decade who both began using personal computers for creative experimentation at about the same time, and whose efforts were retrieved from the floppy disks containing their frozen "seeds" within mere months of one another. And yet, with all those shoeboxes tucked under beds and in basements, much of the most important preservation and recovery work around floppies is being done by individuals, fan communities, and institutions that do not necessarily have big white pillars out in front. Jason Scott (who now works for the Internet Archive, which actually *does* have big, white pillars out in front) was for many years a free-agent, initiating and pursuing his own projects. One person who sought him out was the aforementioned game designer and screenwriter Jordan Mechner. Though Mechner's career had been launched by *Karateka* he would become best known for his *Prince of Persia* franchise, another casually Orientalist series of titles growing ever more sophisticated as they migrated to different platforms and publishers, culminating in a feature-length Disney film in 2010. Mechner is a self-described packrat, having saved arcana from every stage of his career. Fans, for example, can go online to peruse the original sketches and storyboards done for *Karateka*. And yet, like some Derridean parable, Mechner's personal archive contained an absence at its very center: the original source code for the first Apple release of *Prince of Persia* (1989), maddeningly missing for many years. Enter Mechner's father, with shoebox: cleaning house he had found a cache of floppy diskettes, which he shipped to his son. Among them was one whose label suggested it might contain the long-lost code.

The rest of the story is quickly told. Mechner enlisted Jason Scott, who in turn brought in a retrocomputing expert named Tony Diaz. Attended by a reporter and photographer from *WIRED*, the trio convened at Mechner's homestead in Hollywood. The diskettes Mechner's father had found were literally covered with dust, and there was no guarantee a successful recovery would be possible; nonetheless the stage had clearly been set for an event. Diaz had his methods, including gently bathing the diskettes with detergent if need be. He also brought with him an impressive array of vintage Apple II computers that he has hot-rodded with enhancements such as Ethernet ports. A number of bits and

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pieces from Mechner's career were salvaged that day, the *Prince of Persia* code included; also several prototypes of unreleased games. Some of the disks, true palimpsests, contained multiple layers of data, thereby reminding us of another critical affordance of the floppy—that unlike the CD-ROMS that followed them, they were reusable. As narrated by *WIRED*:

> Mechner keeps handing disks to Diaz, and more golden idols keep spilling out. Like many computer kids of his day, Mechner used old floppies and rewrote them with new data. One of them used to hold part of Roberta Williams' early Sierra On-Line adventure game *Time Zone*. Now, Mechner says, it holds the only copy of one of his earliest games.[28]

Scott, meanwhile, was cloning additional diskettes and uploading the salvaged code to GitHub, where it was instantly accessible to onlookers from all over the world—word of the event had leaked out, and people were logged on and waiting. The *Prince of Persia* source code has since been pored over by enthusiasts, shared, commented on, and generally cherished.

WIRED's prose here is worth quoting not only for the color it adds to the description of the event, but also for several other qualities of what we might think of as the shoebox story, an emerging genre of computer folklore. As the headlines read—invoking one of the franchise's most successful installments—the *Prince of Persia* had been rescued from the sands of time. The rescue, however, is (knowingly, one assumes) staged by the journalistic coverage as just such an exotic escapade as is portrayed in the games themselves, replete as they are with acts of plunder and abduction. The tomb raiding is depicted here complete with middle-aged computer geeks in the swashbuckling role of media archaeologists. Complementing this stock set-up is the aura of the lost original, the "only copy" of the isolate object of desire, that oxymoronic phrase embodying all of the contradictions of memory and materiality when that which is unique and precious is preserved through proliferation (digital archivists are fond of the acronym LOCKSS: Lots Of Copies Keeps Stuff Safe).

The technical achievement of this and other data recoveries (like the Leary or the Warhol) is genuinely great; their importance to their constituencies is undeniable; but when the afterimages of these lost floppies come in to contact with cultural imagery as casually well-worn as Indy's leather jacket, they leave the shoebox story at risk of replicating a narrative tradition vexed by acts of appropriation and exploitation. Many of the programs now dormant on quiescent floppies belong to a category known as abandonware, their copyright owners impossible to contact or even identify owing to mergers and takeovers and buyouts in the industry. This is to say nothing of the personal data that inevitably turns up on diskettes, raising issues of ethics and privacy. Who has the rights to the collective heritage of a moment described by one of its participants, a member of the computer underground, as follows: "'People' who never existed did things that never took place, upon a stage of fragmented software that currently sits on a hundred thousand disks in dusty boxes, chronicling events that happened only by mutual wish-fulfillment."[29] What happens, in other words, when the

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owner and originator of the source code is not there standing over the shoulder of the experts seeking to retrieve it?

A corresponding frame of reference can be found in the assiduous work of the Software Preservation Society (SPS). The imposing name notwithstanding, they are a tiny group of technologists based in the United Kingdom who have dedicated themselves to creating solutions for locating, duplicating, documenting, and preserving disk images of classic computer games, especially those released for the Commodore Amiga. They are also an advocacy group who are vocal about the need for game preservation, and they are distinguished by a radical commitment to authenticity, meaning that they will only acknowledge as legitimate those disk images that can be proven to have originated from unaltered factory-written exemplars of the original title. "I don't count games as preserved if they have been modified in any way by a third party, not only that, I do not count games as preserved if they cannot be proven to be unmodified", they write on their Web pages. "Museums", they go on to note, "expend a large amount of effort and money in determining the originality of the artifacts they hold."[30]

As the willful and repeated comparison to museum curation and traditional artwork makes plain, the SPS sees itself as part of a cultural heritage continuum that seeks to employ the same stringent standards of authenticity and verification commonplace in traditional conservation to the arena of computer games and software. Software and games, however, were especially vulnerable to corruption as unauthorized (pirated) copies were passed from hand to hand. Sometimes (as happened with Mechner's own diskettes above) fragments and traces of past programs remained readable on the media; moreover (as we have also seen) because of the competitiveness between rivals, so-called "crack screens" (soon to become demoscenes) were frequently grafted onto the opening credits of a pirated game so a cracker could enhance their reputation. Finally, most home computer games shipped without the write-protect feature on the diskette enabled, which was necessary in order to accommodate many seemingly mundane features of gameplay, including saving high scores back to the disk and saving game sessions in progress. No disk that cannot be proven to have been unaltered from a factory-level master can therefore be wholly reliable as a preservation copy because there is no guarantee that the actual software's functionality has not been compromised at some point in its past life; in other words, any written intervention in the disk's data—a saved game, a crack screen—could, in theory, introduce bugs that would crash the program or otherwise corrupt its behaviors. Given the radically constrained storage space on a disk, this was more common than people realize; crack screens and demoscenes, for example, were sometimes added at the expense of actual program data.

The technology with which the SPS is closely associated is a hardware device called the Kryoflux, one of several controller cards available for connecting legacy disk drives to modern systems for purposes of data migration (see Figure 21.4). Unlike its competitors, however, the Kryoflux operates at the symbolic register of the actual magnetic encoding on the disk, the "fluxes" whose sequences

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are mathematically reconstituted as the zeroes and ones of binary computing. For floppy disks do not store anything as simple as actual bits; rather, they record sequences of magnetic flux reversals that are themselves encoded using recondite schemas bearing names like Run Length Limited and Group Code Recording. Magnetic Force Microscopy, a variation on electronic microscope technology, is able to visualize the fluxes on the surface of the media, yielding startling, alien imagery which—though it encourages us to resort to inscriptive metaphors like "read" and "write"—is properly apprehended as a signal the firmware seeks to interpret from the media. Not magnification then, but stochastic prediction and rendering.[31]

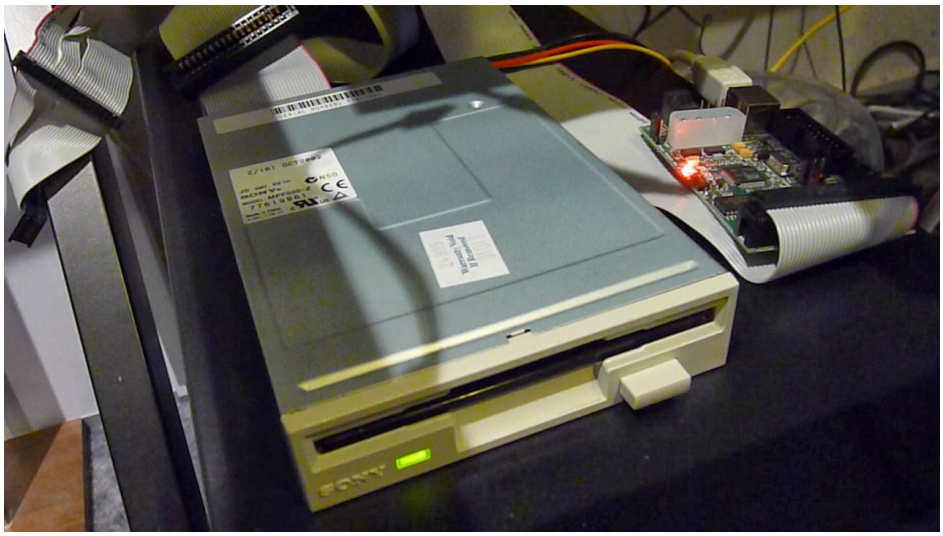

Figure 21.4
A Kryoflux (at right) in use with a 3½-inch Sony drive. Source: http://amigax1000.blogspot.com/2014/03/kryoflux-on-x1000-and-a4000t.html.

The archivist-turned-media-theorist Wolfgang Ernst anticipates what is at stake in these obscure details and terms: "Technological media that operate on the symbolic level (i.e., computing)," he writes, "differ from traditional symbolic tools of cultural engineering (like writing in the alphabet) by their registering and processing not just semiotic signs but physically real signals."[32] These signals (or fluxes) are temporal rather than semiotic markers, very much manifestations of the time-criticality and micro-temporalities Ernst understands as definitive of modern media; or, as the SPS put it with regard to the Kryoflux, "Reading … can be done by timing, at a very fine resolution, how far the flux transitions are apart and then deriving the intended bit cells."[33] In other words, the appropriate frame of reference here is sampling as much or more than inscription; and within this frame, we enter into wholly new registers of media perception and individuation; what others have termed *variantology*: "We can see when this happens as each mechanical drive has its own 'fingerprint,' made by the 'crackles and pops' unique to each one", claims the SPS. "Disk images made from commercially mastered disks have far less of these mechanical stutters due to the high quality equipment used."[34]

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And yet, the higher the tolerances of the hardware, the more chimerical the quest for absolute fidelity becomes. Practitioners working with the Kryoflux report that even routine fluctuations in the electrical current being used to power the drive can impact the rendering of the flux stream as captured by the device. "Computing", as Jean-François Blanchette observes, "is material through and through. But this materiality is diffuse, parceled out and distributed throughout the entire computing ecosystem."[35] If that ecosystem includes not just magnetic flux transitions but the very electrical current—the deep core of the power grid itself—then we should ask what media archaeology ultimately seeks to excavate, or more precisely how far down those excavations go, and where the fault-lines finally tremble. Get close enough to the metal and you just might find a wormhole waiting there, one that leads back outward, to the planetary-sized ecosystems on the other side that are necessary to still spin these diminutive disks containing worlds.

Flash Back

There are other shoebox stories to tell. One might be the restoration of Canadian writer bpNichol's "First Screening", a suite of text experiments for the Apple II, from a twenty-two-year-old floppy disk.[36] One might be the capture and release of a disk image of William Gibson's elusive electronic poem "Agrippa", famously designed to (appear to) encrypt itself after a single reading; with the disk image now in hand the text can be read any number of times in an emulator, thus preserving the poem's existence while, arguably, destroying its very essence.[37] And then there is the shoebox story that centers around widely publicized efforts to locate and restore copies of the earliest HTML "pages" ever published on the Web. This one also made headlines: "The first draft of the World Wide Web has gone missing", technology news outlet CNET reported in May 2013, "with perhaps one of the only copies of the very first Web site floating around the world's drawers or attics on a floppy disk somewhere."[38]

The story is actually more complex than that: as National Public Radio in the United States was the first to relate, in 1992 Tim Berners-Lee had saved a complete copy of the early CERN site to a 3½-inch floppy for use in demos while traveling. (A first generation "Web site", after all, was just a collection of non-dynamic text and image files that could be accessed locally from removable media as easily as from a Web server.) A version of the 1992 CERN site in this state had, in fact, been intermittently available online for some time.[39] CERN's very first Webpage, however, was created in 1990; the speculation, therefore, is that a version of it from as much as two years earlier than Berners-Lee's demo disk might also still exist, most likely not on a floppy but a large-format optical disk. "It was such a beautiful object, that optical disk, that someone maybe has it on their coffee table or their bookshelf", NPR quoted CERN's current Web historian Dan Noyes.[40] There are, then, two separate disks in question, the 3½-inch demo floppy and the absentee optical disk. Several days after the initial NPR story, the University of North Carolina's Paul Jones reported having a copy of the CERN site—retrieved from yet a third disk—dating from 1991. Likely other copies are extant as well. The story illuminates a complex, non-progressive historiography in which portions of the early

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Web were routinely downloaded and consigned to floppies and other removable media, either as backups, demos, and the like. The floppy disk, universal iconic token of obsolescent media, thus becomes the conveyor and purveyor of the very earliest incarnations of a contemporary medium that we are routinely asked to accept as having now assumed its apotheosis in "the cloud".

If, as Erkki Huhtamo claims, media archaeology is the study of "cyclical phenomena which (re)appear and disappear and reappear over and over again in media history and somehow seem to transcend specific historical contexts", then floppy disks ought to be a primary object for such attention.[41] The "poor black squares" preemptively eulogized by Jason Scott are easily mistaken for transitional technologies, inserted into computing history between the industrial regimen of tape and the silent, invisible, always-increasingly capacious hard drives that replaced them, along with other near-forgotten disk formats such as Zip and Jaz, and optical media such as CD-ROMs. None of these, however, has instilled the affection in their users, and none have proven so iconic of what it means to "save" something digitally. The stubborn resilience of the floppy's reappearance in media histories and the persistence of its afterimages perhaps suggests why neither the raiding of lost antiquities nor the kind of curatorial fundamentalism espoused by the SPS are the most appropriate range of reference for their continued significance today.

On the contrary: Floppies are not rarefied or precious; they were and are ordinary everyday media, ragged and gummy, often dust coated, maybe a touch ridiculous in retrospect. (One much loved bit of lore has it that the 5¼-inch square was derived from the size of the cocktail napkins at the bar frequented by technicians from Shugart Associates, the firm that did the engineering work.)[42] They were not black-boxed like a hard drive or shiny and cyber-slick like a CD-ROM. Floppies, whose physical dimensions became common synecdoche for the objects they delimited, were as much a product of their moment as monochrome screens and dot matrix printers. But they were somehow more intimate than either, the object that passed from the hand of the user to the mouth of the drive and thereby brought the machine to life with a game that had been saved in *medias res* the previous afternoon or a letter or a manuscript that was slowly taking form. Floppies were where the data lived, and where people's digital lives slowly accumulated. They are perhaps, as William Gibson indeed recognized in "Agrippa", most closely analogous to snapshots, something else we tend to keep in shoeboxes and something else whose afterimages remain with us long after the original has passed from view.

The not yet obsolesced media technology that comes closest to the floppy in spirit is surely the "flash" USB stick, which is also a semi-disposable readily portable form of storage suitable for accessorizing and casual exchange. "These days, the things that seem to turn up all over the place—lurking in pockets of different bags, filling drawers, and junk boxes, dropped down the back of desks … There is almost certainly one within ten feet of you right now", writes information scientist Paul Dourish in an article in *The Atlantic*.[43] He notes that despite the pervasively networked world we inhabit, flash drives are still among the most reliable ways of moving data from one computer to

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another, especially on the spur of the moment—across the table in a coffee shop for example, or in a meeting.[44] For Dourish, "The flash drive exposes the great lie of technological progress, which is the idea that things are ever really left behind." This is a sentiment similar to that which we have already seen in Acland, Sterne, Ernst, and Huhtamo, but Dourish here has something quite specific in mind. Flash memory sticks, it turns out, employ a technology known as the File Allocation Table (FAT) to manage the data we store on them. First introduced in 1977, the FAT was originally developed at Microsoft for use with—you guessed it—the floppy disk.

Notes

A handful of non-contiguous sentences (and associated notes) were originally published in a different context in my *Track Changes: A Literary History of Word Processing* (Cambridge: Harvard University Press, 2016), pages 219–220.

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[1] For the complete GAO report, see: www.gao.gov/products/GAO-16-696T.

[2] There have been similar nexuses of humor in the past; for example in the wake of the complications around the initial online rollout of the Affordable Care Act in 2013, a satirical *Onion* story about a "new and improved" Obamacare website to be released on 35 floppy disks. See www.theonion.com/article/new-improved-obamacare-program-released-on-35-flop-34294. *The New Yorker*, meanwhile, ran a Barry Blitt drawing entitled "Reboot" for its November 11, 2013 cover, depicting President Obama—oversized cordless phone in hand—standing next to an anxious Katherine Sebelius and an aide inserting a floppy disk into a hulking desktop computer.

[3] Brian Fung, "The Real Reason America Controls its Nukes with Ancient Floppy Disks," *Washington Post* (May 26, 2016). www.washingtonpost.com/news/the-switch/wp/2016/05/26/the-real-reason-america-controls-its-nukes-with-ancient-floppy-disks/?utm_term=.a067ed37c1a6.

[4] See Charles R. Acland, "Introduction," *Residual Media* (Minneapolis: University of Minnesota Press, 2007), pages xix–xx.

[5] Debates over whether to replace the floppy icon are a staple on tech blogs and discussion forums. Connor (Tomas) O'Brien considers the issue from the standpoint of graphic design and notes that the floppy's distinctive shape, with one beveled corner, contributes toward the icon's being uniquely recognizable: http://connortomas.com/2013/04/in-defence-of-the-floppy-disk-save-symbol/.

[6] http://instagram.com/p/WdgkYcwaxd/

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[7] Jacques Derrida, "The Word Processor," *Paper Machine*, trans. Rachel Bowlby (Stanford: Stanford University Press, 2005), 29.

[8] See www.theatlantic.com/entertainment/archive/2014/08/the-man-who-made-off-with-john-updikes-trash/379213/.

[9] See http://nymag.com/selectall/2016/04/princes-legendary-floppy-disk-symbol-font.html.

[10] Karl Ove Knausgård, *My Struggle: Book Five*, trans. Don Bartlett (New York: Archipelago, 2016), 396. I am grateful to Justin Tonra for pointing out this passage.

[11] See www.jimgoldenstudio.com/Portfolio/Relics-of-Technology/thumbs.

[12] See www.miaminewtimes.com/arts/nick-gentry-brings-floppy-disks-back-to-life-at-robert-fontaine-gallery-6501192.

[13] See www.popularmechanics.com/technology/audio/a21740/floppy-disk-orchestra-star-wars/.

[14] See www.thisiswhyimbroke.com/floppy-disk-table/.

[15] For more on IBM's RAMAC and the history of early hard drive technology see Kirschenbaum, *Mechanisms: New Media and the Forensic Imagination* (Cambridge: MIT Press, 2008), especially chapter 3.

[16] Jerry Pournelle, *The User's Guide to Small Computers* (New York: Simon and Schuster, 1984), 61.

[17] In fact the industry experimented with a number of different form factors, most notably the 3-inch disk developed for use with the popular Amstrad computer line in the UK.

[18] According to www.dailymail.co.uk/sciencetech/article-1269142/Floppy-disks-terminated-Sony-stops-production.html.

[19] See www.newyorker.com/books/page-turner/when-robert-pinsky-wrote-a-video-game.

[20] For an introduction and overview of the demoscene, see *Demoscene: The Art of Real-Time*, ed. Lassi Tasajärvi (Helsinki, Finland: Even Lake Studios, 2004).

[21] For more on this technique, see: http://fabiensanglard.net/prince_of_persia/pop_boot.php.

[22] Watch it (or don't) at: www.youtube.com/watch?v=up863eQKGUI.

[23] See http://ascii.textfiles.com/archives/3191.

[24] For specifics of this process, see Kirschenbaum, "Ancient Evenings: Retrocomputing and the Digital Humanities." In *A New Companion to Digital Humanities*, eds. Susan Schreibman, Ray Siemens, and John Unsworth (Hoboken, NJ: John Wiley, 2016): 185–198.

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[25] Jonathan Sterne, "Out with the Trash: On the Future of New Media." In *Residual Media*, ed. C.R. Acland (Minneapolis: University of Minnesota Press): 16–31.

[26] Read the press release here: www.cmu.edu/news/stories/archives/2014/april/april24_warholworksdiscovered.html. And the complete technical report here: http://studioforcreativeinquiry.org/public/warhol_amiga_report_v10.pdf.

[27] www.wired.com/2013/10/timothy-leary-video-games/. See also James A. Hodges's technical report on *Mind Mirror*, Leary's only commercially published game: http://mediaarchaeologylab.com/wp-content/uploads/2016/10/JamesHodges_MindMirror_MALwareTechnicalReport_10-2016-1.pdf.

[28] Gus Mastrapa, "The Geeks Who Saved Prince of Persia's Source Code from Digital Death," *WIRED* (April 20, 2012): www.wired.com/2012/04/prince-of-persia-source-code/.

[29] The quotation is from Patrick K. Kroupa, "The Akashic Records of Cyberspace" (1993): http://exciteddelirium.net/the-akashic-records-of-cyberspace/. Kroupa was the founder and proprietor of the quasi-legendary computer bulletin board MindVox.

[30] See www.softpres.org/article:importance_of_digital_preservation and www.softpres.org/article:importance_of_data_authenticity.

[31] For more on MFM and these other details, see Kirschenbaum, *Mechanisms*, especially chapter 1.

[32] Ernst, "Media Archaeography: Method and Machine versus History and Narrative of Media." In *Media Archaeology: Approaches, Applications, and Implications*, eds. E. Huhtamo and J. Parikka (Berkeley: University of California Press, 2011): 242.

[33] See www.softpres.org/glossary:bit_cell.

[34] See www.softpres.org/faq:imaging_disks:disk_modification.

[35] Jean-François Blanchette, "A Material History of Bits," *Journal of the Association for Information Science and Technology* 62.6 (June 2011): 1042–1057.

[36] For details see https://vispo.com/bp/introduction.htm.

[37] See Kirschenbaum et al., "'No Round Trip': Two New Sources for *Agrippa*," *The Agrippa Files* (December 2008): http://agrippa.english.ucsb.edu/kirschenbaum-matthew-g-with-doug-reside-and-alan-liu-no-round-trip-two-new-primary-sources-for-agrippa.

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[38] CNET reported the story on May 23, 2013: http://news.cnet.com/8301-17938_105-57585922-1/search-is-on-for-lost-first-draft-of-first-web-page/. For NPR's original May 22 piece, see: www.npr.org/2013/05/22/185788651/the-first-web-page-amazingly-is-lost. A May 30 follow-up in *The Atlantic* details Paul Jones's discovery: www.theatlantic.com/technology/archive/2013/05/world-we-have-lost-the-first-webpage-professor-oh-i-have-a-copy-of-it-right-here/276387/.

[39] Currently available here, at the original URL: http://info.cern.ch/hypertext/WWW/TheProject.html.

[40] The "beautiful object" in question is a Canon optical disk manufactured for the NeXT computer: "Steve Jobs' vision for the future was simple: without any other kind of permanent storage, users would keep their entire universe of files and operating system on a disk. … They could move from machine to machine, taking with them hundreds of megabytes of digital files." See www.thegogglesdonothing.com/archives/2010/03/next_optical_discs.shtml for more.

[41] Huhtamo, "From Kaleidoscomaniac to Cybernerd: Towards an Archeology of the Media": http://web.stanford.edu/class/history34q/readings/MediaArchaeology/HuhtamoArchaeologyOfMedia.html.

[42] As narrated here, for example: http://archive.computerhistory.org/resources/text/Oral_History/5.25_3.5_Floppy_Drive/5.25_and_3.5_Floppy_Panel.oral_history.2005.102657925.pdf.

[43] Paul Dourish, "Why Flash Drives Are Still Everywhere," *The Atlantic* (June 30, 2016): www.theatlantic.com/technology/archive/2016/06/why-flash-drives-are-still-everywhere/489458/.

[44] Flash drives are also the backbone of samizdat information exchange in places where networking is either not ubiquitous, or subject to authoritarian control. In Cuba, for example, this system is known as *El Paquete*. See www.fastcompany.com/3048163/in-cuba-an-underground-network-armed-with-usb-drives-does-the-work-of-google-and-youtube.

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