Time's Sublimest Target: Practices of Forgetting in HCI and CSCW

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In our contemporary moment, there exists a hegemonic design practice and a general social desire to retain information. With the help of sociotechnical platforms and other contemporary technologies, information has changed its temporal and spatial boundaries, creating unbounded, algorithmic, and emergent forms of retention. The consequences of such retention are numerous, ranging from an overabundance of autobiographical information that cannot be fully understood by the individual to the improper use and economization of such information by state and corporation alike. Within this context, this paper investigates a counter-hegemonic practice of forgetting, specifically from the perspective of human-computer interaction and computer-supported cooperative work research, with additional insight drawn from adjacent fields. In doing so, we present forgetting as a significant area of research with HCI and CSCW, a burgeoning and contradictory space that may offer solutions to issues we face within a moment of persistence by default. This paper also explores potential directions for future research and design on forgetting in HCI and CSCW through an investigation of an art piece by Chinese artist Song Dong.

CCS Concepts: • **Human-centered computing** → **HCI theory, concepts and models**; • **Social and professional topics** → Privacy policies; • **Applied computing** → Fine arts.

Additional Key Words and Phrases: Forgetting, deletion, temporal, spatial, retention, intent

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1 INTRODUCTION

> *Construction with glass.* Height 13 ft. Width 9 1/2 ft. Materials. Glass, metal, adhesive tape. Technique. The glass sheets suspended by adhesive tape fall on to the concrete ground in a pre-arranged sequence.—Gustav Metzger (1961) [83]

Broadly, this work investigates memory practices with a specific focus on the practice of forgetting. Within memory practices, forgetting is less discussed but still considered necessary [4]. This tension—both important and overlooked—is on display in the definition of technologically-mediated memory: "any technology that... encodes, stores, and retrieves autobiographical information" [71, p.23]. In such a definition, memory technologies are considered any technology that *retains*.

This work, then, is specifically an investigation into technologically-mediated memory with a view toward the overlooked but important practice of forgetting. In doing so, we investigate previous research within human-computer interaction (HCI) and computer-supported cooperative work (CSCW), with additional evidence drawn from science and technology studies (STS),

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ubiquitous computing (ubicomp), personal information management (PIM), memory studies, and literature. This is a significant area of research in our contemporary moment. If the 20th century had remembered too much [77], the 21st century appears poised to surpass it, with technologies that have further complicated remembering and forgetting: that which was once ephemeral became tenacious; archival ease led to an explosion of data that was both revelatory and difficult to parse; sites of memory and their communities have shifted, leading to new formations of remembrance (and forgetting); persistence relies on corporate retention of information; the means of memory production have been both diversified and constrained.

Below, we have broken this work into fourths. First, we present a case for forgetting, summarizing the significance of forgetting in our contemporary moment. Second, we meditate on the generative complications within contemporary practices of forgetting, considering how the practice of forgetting is perceived socially, who owns what (and who can forget what), and the co-option of forgetting practices by corporate and political interests. Third, we form a taxonomy of forgetting research within HCI, CSCW, and adjacent fields, focusing on six general categories of forgetting research (pure, performative, temporal, spatial, visual, and unintentional forgetting). Fourth, we end with a meditation concerning the performance art piece *Writing Diary With Water*, a work by Chinese contemporary artist Song Dong. We emphasize Song's art as pivotal for future research on forgetting due to his focus on historic methods and practices, his emphasis on individual agency, and his framing of forgetting as a form of expression. Overall, this work argues that current technologies are often operating under a *persistence by default* logic (as termed by boyd [105]), a dominant form of design and a hegemonic social desire that has evolved alongside our desire to remember, from ars memoriae and externalized alphabet to photographs to Facebook Memory. We present forgetting as an oft-ignored and under-researched aspect of HCI and CSCW, a counter-hegemonic practice that nonetheless informs the hegemonic practice of remembering. Still, even within research on forgetting, we note that designing for retention is a persistent impulse, and forgetting is often undertaken performatively. As such, at present, "forgetting" as a practice is complicated and contradictory—and ready to be considered anew.

2 THE CASE FOR FORGETTING

2.1 Our contemporary moment

As Hayles notes, "humans and technics have coevolved together" [59, p.10], with humans and technology having coevolved to favor retention over forgetting. In keeping with our focus on technologically-mediated memory, we consider how, per Winograd and Flores, "in designing tools we are designing ways of being" [133, p.xi]. Our contemporary moment has its spirit encapsulated in Bush's "As We May Think," an essay that has been noted as the progenitor of life-logging technologies [54]. In the essay, Bush proposes an information retrieval and management system to augment memory and knowledge called the Memex ("memory extender") [18]. Per Bush,

> When data of any sort are placed in storage, they are filed alphabetically or numerically (...) [they] can be in only one place, unless duplicates are used; one has to have rules as to which path will locate it, and the rules are cumbersome. (...) The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts (...) Man cannot hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it. [18]

Here, Bush proposes a memory extender that would take as its main feature "associative trails" of indexing and annotation based on personalized systems of interests and connections that allow

for rhizomatic discovery and browsing that can be networked with other associative trails shared among collaborators—trails that "do not fade" [18].

In this vein, contemporary technologies have taken the externalization and industrialization of memory along a continuum of progress towards collaboration, association, and the impeding of slippage and disappearance. For instance, a material photograph can be digitized, duplicated infinitely, and instantaneously moved across space. Twitter's archive of public Tweets has been donated to the Library of Congress for preservation and research—millions of minor artifacts cataloged by their own logics for recall [43]. The predominance of the internet is based on associative trails, where individuals hyperlink and share information based not on staid alphabetical categorization but, instead, upon personal preference.

Additionally, retention is now easier than ever: take boyd, who noted, "It wasn't that long ago that storage was expensive and people were forced to toss data; the fact that we do not have to do so now is often relished" [105]. This has created an overabundance previously unthinkable, an "enduring ephemeral" in which digital archival practices retain more information than ever, but such retention renders engagement with said information fleeting and difficult to maintain [26]. Contemporary memory practices also present a shift from "individual exteriorizations of memory" as seen in early paradigms to "large-scale technological systems or networks that organize memories" [109]. As Stiegler notes, these sociotechnical systems are significant for how they can systematically order memories according to their own logics. For instance, sociotechnical platforms like Facebook automatically archive and re-present information collected by its users according to the logic of its systems, such as Facebook Memories [94]. In our contemporary moment, new technologies determine the intent to remember (or forget) and the interpretation of what may or may not be valuable to remember (or forget). As such, Prey states that what is currently at stake is "*what* is remembered, *how* it is remembered, *how* it is re-presented to us, and, ultimately, what is *not* remembered for us—what is forgotten" [94, p.220].

2.2 The case for forgetting

If we have a dominant desire to retain, what are the individual, social, and political benefits of forgetting? We do not take the position that either remembering or forgetting is most valuable—they each have their time and place. However, in fully considering forgetting, we are able to take a more nuanced approach to human-computer interaction and acknowledge that, sometimes, there is a disconnect between the ways technologies are designed and operated at present and the ways we may want technologies to be designed and operated in the future.

First, we should unpack the case for remembering. Aided by the decreasing cost of storage and the rise of cloud computing, forgetting is often framed as an undesirable, irreversible state that can now be mitigated: "We explore how we could build personal digital stores that save every bit of information we have touched or record every event we have experienced through our entire lifetime" [116, p.90]. Indiscriminate keeping and retention were the predominant interests of lifelogging technologies and personal information management (e.g., [64] although this has changed, see: [104]). There is also a user-driven preoccupation of "just-in-case"—as the future is difficult to anticipate, individuals tend to keep information in case it is ever needed in the future: one is better safe than sorry [104]. The field of human-computer interaction is concerned with making interactions between humans and computers smoother [67], a stated goal that has been interpreted in this context as making the retention of data an easy process: "[M]uch new work centres on retrieval of media and how this supports remembering" [119, p.2]. Baym and boyd's affordances of online networks speak to a dominant desire to keep and retain: persistence, replicability, scalability, and searchability [9]. Socially, remembering is tied to retention of self, family, and community (e.g., [29, 69]). Aging successfully has been tied to aging alongside one's memories [1]. During the 20th

century, there was a "heightened sense of urgency" to remember, a desire to witness as a political act against archival and political fascism [40, 78, 126].

With all of this in mind, we map a case for forgetting within contemporary research. First, *forgetting is a necessary component of memory*. Individuals "declutter" [22], working memory has its limits [5], archivists exist to delimit [51], the metaphoric River Lethe aids in forgetfulness [126]. Contemporary cognitive research has noted the significance of forgetting in preventing cognitive overload [98]. As in Borges [14], if one remembers everything, one remembers nothing, and "when it is no longer possible to decide what is of importance, then everything loses importance" [55, p.25]. In this way, forgetting is an "adaptive mechanism" [101], without which we would be inundated with memory. Our globally networked information society compliments Sontag's declaration that modernity is characterized by "garbage-strewn plenitude" [107]. This contemporary plenitude has been termed an "accumulated digital burden" [117] and an "infinite basement" [65] predicated on "effortless abundance" [111] and "benign neglect" [65]. The solution to such "digital hoarding practices" [117] is forgetting.

Second, *forgetting prevents context collapse*. One individual is a multitude of contexts, different presentations of self for different groups of people, each with their own mercurial and supposed front-stages and back-stages. Digital practices, with the help of social media sites such as Facebook, compress all these contexts into one, creating context collapse, as when family sees a photograph intended for friends [25, 62, 92, 137]. Combined with online network affordances like persistence and replicability, context collapse can be an enduring issue without the ability to forget [127].

Third, *forgetting is morally and politically significant*. As noted by Ditchev and quoted in Bannon, "A developed civilization develops not only techniques to remember, but also to forget, to give a chance to new generations, to open new ways of living and thinking" [4, p.8]. In thinking with this quote, there are moral and political considerations to forgetting. Technological systems of remembering have political power, such as the predictive power of PredPol, a policing software system that "predicts" where crime will be done by using previous crime statistics to create predictive analytics—a "crime production algorithm" [10, p.83]. Marx notes that police surveillance "transcends time" as it can exist in stasis over time, to be recalled "in totally different interpretive contexts" [81, p.150]. Quoting Marx, Blanchette and Johnson concur that information is "easily amenable to a variety of treatments (...) precisely aimed at extracting new information from the vast warehouses of electronic information gathered by organizations" [13, p.11]. Similarly, corporate retention of information is tied to surveillance capitalism and the economization of personal information [139].

This issue—of "socially freeze-dried" information [50] —finds its solution in "the right to forget" and a social desire to forgive. The right to forget is "not just about selective access but about selective *retention*" [13, p.2]—in other words, a possibility to forget that Dodge calls "emancipatory" [34]. Flaherty calls the right to be forgotten ("including the ultimate anonymization or destruction of almost all personal information" [42, p.380]) "fundamental" while Blanchette and Johnson characterize historical and contemporary processes of forgiving, like the erasure of juvenile criminal records, as "necessary" [13]. Elsewhere, Enwezor notes the imperial nature of retention and its "insatiable appetite for knowledge of the unknown" [40] while Winesmith and Anderson investigate how and when to forget indigenous arts and knowledge practices, in the context of contemporary museum curation [131].

Another moral consideration is the environmental impact of retention. The impacts of digital retention are vast, and there are questions as to the sustainability of our rates of storage, electronic waste, and the high energy consumption of generative AI—essentially, systems that present dynamic recombinations of learned information. As per Monserrate: "the environmental costs of ubiquitous computing in modern life are obscured by the sheer complexity of infrastructures and supply

chains involved in even the simplest of digital transactions" [85]. In this way, the persistence of data presents an environmental question to which the answer is being developed [121].

In sum, forgetting is a significant practice, as worthy of study as remembering. In the spirit of the present definition of technology-mediated memory, contemporary technologies have encoded, stored, and retrieved to a degree previously unknown. Thus, research that makes the case for forgetting does so in response to (and in the shadows of) contemporary retention. As such, forgetting is presented as necessary in the context of our accumulated and shared digital burden; forgetting is important when considering self-presentation and persistence of information online; forgetting has environmental implications; and forgetting is a moral and political act in the face of imperial, corporate, and state retention of digital information.

3 COMPLICATIONS TO FORGETTING PRACTICES

In thinking with the hegemonic practice of remembering and the counter-hegemonic practice of forgetting, three considerations come to mind: 1) If default retention by sociotechnical systems is a hegemonic practice, how is forgetting by sociotechnical systems perceived socially? 2) In a hegemonic regime of remembering, who owns what? and 3) If counter-hegemonic practices are often appropriated by dominant regimes, has this occurred with forgetting practices? We investigate these questions through the instant messaging/social media platform Snapchat—the most popular "forgetting" technology. In doing so, we note the complicated social and political nature of forgetting as a practice.

3.1 How is forgetting perceived socially?

To date, Snapchat is the grandest example of the integration of forgetting into a sociotechnical system: since launching in 2011, Snapchat has attracted over 750 million monthly users [90]. In HCI and CSCW research, Snapchat is framed as a slice-of-life platform where individuals can share ephemeral moments from their day [8, 20]. Its forgetting feature allows for lightweight and "casual" communication where users feel comfortable sharing a "true" self [21, 135]. However, a preference for forgetting can be seen as a clandestine desire. As boyd notes, "a persistence-by-default-minded assumption is that anyone who doesn't want their data to be persistent *has something to hide*" [105, p.21]. Such a mindset can be seen in privacy literature, in which consumers are noted as being disinterested in privacy laws and security features as they have "nothing to hide" [138]. In early ephemeral technologies research by Geambasu et al., a noted benefit to ephemeral technologies is that their data will not "come back and bite you"—a suggestion that the only things worth forgetting are those that may be damning [47].

In keeping with the presumption that forgetting features are clandestine features, Snapchat has been both socially and academically understood as a platform for illicit encounters. As tech website BGR puts it: "Argue though its executives might, Snapchat is good for two things: sending photos and videos of yourself making stupid faces, and sending photos and videos of yourself naked. The latter, of course, is the more compelling function since that is exactly what the app was designed for" [41]. Such an argument, though, is not reserved for popular websites but is also understood academically through a focus on Snapchat's carnal content, even if such practices are found to be minimal (e.g., [57, 93, 99]). In this way, one can compare Snapchat to Polaroid, another youthful product that was socially understood to conflate privacy and intimacy: "no need to send off those potentially embarrassing images to a photo lab..." [111, p.102].

3.2 Who forgets and who remembers?

In the usual printing of film, ownership is temporarily relinquished, during which the photographer's *negatives* are translated into the photographer's *photographs* by a developer. In the Polaroid

example above, ownership at the moment of development is retained by the photographer. Digital photographs progress beyond Polaroid in their instantaneous development [128]—however, in all cases, ownership can change hands when the photographer gives the finished images to whomever they please. In the contemporary moment, ownership changes hands countless times as individuals relinquish their information to countless developers. Hegemonic retention and remembrance make it difficult or impossible for those who desire a reclamation of ownership to get it back [127]. While users of platforms retain technical ownership of information stored on platforms, these platforms are both archival depositories and profiteers from such use of information, interlinking themselves with digital legacies—thus, users are not the exclusive owners of their information [139]. The question, then, is who owns what, who remembers, and who forgets? [12, 94].

Systems like Snapchat or WeChat Moments can be presented as a response to such questions, a step in an alternative direction. WeChat Moments acts on an "ephemerality for them, persistence for me" principle, in which users can set manual dates for the public expiration of information that can, then, be retained by the user themselves [62]. Similarly, Snapchat presents a change in agency whereby ownership is reclaimed by the sender [135]—the receiver of Snapchat content does not become part-owner of received content unless one *circumvents its ephemeral affordances* [20]. In these examples, technical affordances inform who remembers what and when—the systems allow for dynamic ownership that relies on the system for storage and presentation.

However, such systems are not just depositories for information but active participants that change what users attend to. For instance, a change in the algorithmic system of Facebook's On This Day represents a change in what is being presented as important to remember and what is deemed unimportant and forgotten [37, 94]. As storage and interactions become increasingly mediated by technology and as diverse information depositories are consolidated into major corporate platforms, it becomes more necessary to critically examine the ontology of algorithmic systems. Such explorations may address pressing questions about ownership. Additionally, these examinations could reveal how design practices and platform interventions shape and influence how users remember and forget, thereby making visible the ways in which these systems actively participate in shaping individual and collective memory. In a different space, Kotliar shows how a start-up's technology and eventual socioeconomic power were predicated on the tangential insight that mouse movements are purposeful "digital body language" [72]. How can insights into the design of systems and system updates change how we understand technologically-mediated forgetting? Such research follows Winner, who called for future research into the social construction of technology to place a greater emphasis on the social dynamics and social consequences of technical choices [132, p.371]. For now, the questions of who forgets, who remembers, and how those practices occur, are often hidden from the users' view.

3.3 The co-option of forgetting

Murphy considers counter-hegemonic practices as liberatory for their production of "possibilities counter to or cutting across dominant ways of apprehending reality" [87, p.14]. However, these practices can be appropriated by dominant actors and discourses—"what is done in one assemblage is actively undone in another" [87, p.14]. In her work, chemical manufacturers crafted dominant methods of detecting airborne chemicals to undermine growing concern over the use of potentially toxic chemicals in indoor building materials. They also appropriated language from concerned office-worker protesters and scientific research done by neutral parties. At the same time, tobacco companies joined protesters in their fight against indoor pollution and chemical corporations, sponsoring research that shifted the loci of blame for illness off of tobacco companies and onto chemical conglomerates like 3M [87]. The uneasy participation of tobacco companies, spurred on by self-interest, seems to speak to tensions in pursuing a heard voice within a difficult conversation.

In the case of Snapchat, the counter-hegemonic practice of forgetting is both a break with a dominant way of apprehending reality and a market-led differentiation affordance. With a multi-billion dollar revenue based predominantly on advertisement, Snapchat has both flaunted its place on the forefront of privacy and forgetting *and* floundered as Apple's privacy measures disrupted Snapchat's ability to target users for digital advertising [31]. Meanwhile, its terms of service agreement presented vague and compromised privacy measures: "We cannot guarantee that the message contents will be deleted in every case" [96].

The disconnect between the corporate retention of data for revenue generation on a platform whose major distinguishing factor is the disappearance of data may speak to counter and dominant realities colliding: the monetization and co-option of forgetting. This can be seen in conversations surrounding other forgetting applications. Ephemeral data app Silent Circle's founder Jon Callas was "surprised" by the high demand for his application among corporate clients, while Confide's founder stated: "Confide is to Snapchat, what LinkedIn is to Facebook" [105, 120]—that is, forgetting for professionals. When applications like Confide were found to be frequently used in the Trump Administration, the House Oversight Committee noted their use could "result in the creation of federal records that would be unlikely or impossible to preserve" [108]. Such uses of forgetting applications prompt a difficult question: *who should be allowed to forget and when?* Even the progressive measures of the right to be forgotten in, for instance, German law requires access to money, legal council, transport, and time which can create an imperfect system whereby only certain individuals can be forgotten and, therefore, forgiven (for a similar discussion on socioeconomic asymmetry in the CSCW context, see: [3]). In regards to the corporate and federal forms of forgetting above, one may consider Gandy and his comment on the ease with which corporations can dissolve without actionable consequence: "Why should corporations as fictional persons already have rights that natural persons still long to enjoy?" [45, p.225].

4 FORGETTING RESEARCH IN HCI AND CSCW

The author and philosopher Umberto Eco once wrote that "there can be no art of forgetting (...) because all signs produce presences, not absences" [38]. However, technologies present the opportunity to investigate forgetting through systems. Here, we synthesize forgetting research to present a taxonomy of forgetting practices within current HCI and CSCW research with supplemental research in the adjacent fields of STS, ubicomp, and PIM. We identify six general forgetting practices: 1) *pure forgetting* or an immediate and total loss of information; 2) *performative forgetting* or a negotiated forgetting without the full commitment to pure forgetting; 3) *temporal forgetting* or forgetting characterized by time; 4) *spatial forgetting* or forgetting characterized by space and environment; 5) *visualized forgetting* or forgetting as something that can be seen; 6) *unintentional forgetting* or forgetting not intentionally facilitated by user or system. Within each section, we define the forgetting practice, note its general characteristics and how it acts in combination with other practices, and provide key examples and actors. In categorizing the ways that forgetting is being discussed and designed within these fields, we provide an initial framework through which to consider future work and shed light on what is being done and what is not being done in the design of forgetting.

4.1 Pure forgetting

As noted above, contemporary technologies that support remembering can lead to context collapse, information overload, and unintended retention. In considering these issues, researchers have turned to forgetting as a necessary practice and one that is a "departure" from our standard logics of "automatic archiving" [135]. Bannon and his work "Forgetting as a Feature, Not a Bug", the wellspring of forgetting research in HCI and adjacent fields, made explicit this point of departure:

"What is necessary is to radically re-think the relation between artefacts and our social world (...) Let us explore some scenarios where the technology might be used to assist in forms of forgetting, rather than remembering" [4, p.11]. There has been a growing recognition that such forgetting is necessary, particularly in conversations surrounding social media [4, 84, 101]. Forgetting, at its most total, has been defined as a "complete loss of storage (deletion of data)" [33]. Such a definition describes *pure forgetting* that is characterized by an immediate and total loss of information and has been termed in previous research as "deletion" [6, 7, 12, 82], "redaction" [86], "eradication" [56], and "annulment" [40, 86].

In moments past, such pure forgetting was understood as plausible. Consider the Platonic ideal of pure forgetting: the tabula rasa, a wax tablet upon which one could write. Its wax face could then be smoothed, its written words forgotten, again a blank surface for new information. The image of the tabula rasa has been used for millennia as an "image of voluntary forgetting" [126]. In more modern times, the computer desktop's trash can assumes an act of pure forgetting—the three-step process of drag, drop, and confirm deletion presents a permanence of action that requires an answer to a wary "are you sure?"

Some research from the contemporary moment mentions pure forgetting, such as in Muller when she examines the personal practice of "redaction," specifically concerning the practice of destroying documents of American affiliation by Afghani individuals during the ascendance of Taliban forces in 2021 [86]. In particular, one HCI work related to pure forgetting stands out. In his work, Bannon suggests the implementation of "self-destructing data" [4] and, three years later, Chi et al. designed an inventive prototype on the idea of self-destructing data. For Chi et al., pure forgetting is built into their prototype PY-ROM ("Pyr" as in "fire", "ROM" as in "Read-only Memory"), a two-sided matchstick that allows for the recording of video on one side of the matchstick and the replaying of the video on the other side. However, the replaying of the memory requires the ignition of potassium chlorate, thus destroying the information [23]. The work considers the ritualistic and meditative power of both remembrance and destruction. In doing so, it suggests a physical solution to digital retention—the ability to "Burn Your Memory Away" [23]. Such a project illustrates the hermetic steps of pure forgetting: an individual produces externalized information (with the aid of technology), the information is retained in one edition, and, upon its reappraisal, is destroyed in its totality. In this case, pure forgetting is a manual process embedded in the design of technology itself—one's hand begins the practice as intended by both designer and user.

4.2 Performative forgetting

However evocative, HCI and CSCW research often seems skeptical of pure forgetting and questions its practical applications—even research concerning deletion often requires the potential for retention. For instance, in Vitale et al., the dual actions of personal information management—keeping and discarding—are investigated [124]. The impetus for such an investigation was the growing need for systems and tools to support the curation of personal data—including deletion. Despite this and even in a paper mapping the design space for forgetting, the authors stopped short of pure forgetting: "It is essential that (...) any action is reversible and any potential risks are mitigated in advance" [124, p.1471]. The work suggests instead "softer actions over the more radical concept of deletion" to ensure no actions are taken in haste that may be regretted at a later date [124, p.1471]. This work is not alone in concluding that pure forgetting is, conceptually, unseemly. In research on the afterlife of relationships post-breakup, the deletion of social media comes with challenges and regrets [101]. For Sas et al., deletion is part of a "crude binary" of existence and non-existence [102], a binary not found in actual practice or design.

Previous work suggests that, despite the intentions of individuals or the design of one particular system, pure forgetting is, simply, difficult to achieve. Digital information is fragmented and occurs

across multiple devices and systems simultaneously. Deletion is often out of the hands of individuals who may want something deleted but cannot do anything about it [12]. Traces of "residual activity" can be found, so even if a person considers their information deleted, it can be reconstituted [84]. Consider science-fiction writer William Gibson's *Agrippa (A Book of the Dead)*. The work was a limited edition bricolage, a multimedia book that contained a poem on a self-erasing encrypted floppy disk purported to erase itself after the completion of the poem—a precursor to the work of Chi et al. [115]. However, despite its intent, the disk's code was hacked and decrypted [36]: the poem and its self-destruction can be seen, rewatched, and shared on YouTube.

The desire to forget is one of increasing importance in our present moment of accumulation [4]. Consider that 59% of teenagers edited or deleted their information and content on social media networks [79]—but were these practices effective? Following Sas et al., it is important to consider the spaces outside the binary of existence and non-existence: can forgetting be supported by systems in ways beyond a digital tabula rasa and in place of burning one's memories away? If pure forgetting is often not implemented within systems design and feels impossible for the individual, what, then, *is* forgetting? In many cases, research in HCI and CSCW tends to promote *performative forgetting*, a practice that suggests a desire to forget, but one without the commitment to forget. Here, forgetting is done by degrees, not in an instant but in an ongoing and negotiated process in which data is suggested to be forgotten while still being retained.

Consider the discarding practices in Vitale et al. above: while mapping a design space for the practice of discarding, steps are taken to impede forgetting ("they are still there *in case they are ever needed*") [124]. Or consider the words of Czerwinski et al.: "We believe that well-designed technology must hide details and deletions, thus eliminating clutter in the oppressive task of managing it, *while still retaining these records for future use*" [30, p.102]. In these instances, researchers suggest that forgetting is a stopgap that belies retention. In some ways, it seems researchers wish to save potential forgetters from themselves. In continuing to think with Sas and Whittaker, pure forgetting is framed as an impulsive practice. In their investigation of post-breakup deletion: "[Deletion's] main limitation is that it is often impulsive (...) Future technologies may help address this limitation" [101, p.9]. Here, technologies are forethought machines, making sure human impulse can be mitigated or negated.

Participants in research also recognize the performative aspect of forgetting practices. For instance, the main feature of Snapchat is its lack of retention: photos or videos cannot be saved and do not have an afterlife, by design. In user-centered studies on Snapchat, users had a positive reaction to the short-term lifespan of their content and discussed its positive affordances [8]. However, participants also noted that it is possible to bypass the ephemerality of Snapchat by just taking a screenshot [20]. Per one participant, after looking at a Snap: "Damn! That was a good photo; I should have saved it" [20, p.1937]. Even within systems where forgetting is a main feature, retention is king.

4.3 Temporal forgetting

Temporal forgetting is a practice of forgetting characterized by time, often thought of in terms of duration. In his early work on forgetting, Bannon calls for "technologies that support ephemeral events," in opposition to technologies that support persistence [4, p.12]. Similarly, Mayer-Schönberger wrote in her book *Delete: The Virtue of Forgetting in the Digital Age* that data should be assigned an expiration date [82]. In 2009, Geambasu et al. proposed Vanish, a system prototyped as both a file application and Gmail plugin, in which information disappears after a set amount of time [47]. Since these calls, platforms such as Snapchat, Telegram, and WeChat have, to varying degrees, supported ephemeral events. Snapchat, for instance, allows for manual expiration dates on content, from twenty-four hours (on Stories) to 1 to 10 seconds (on Chat) [8, 135].

Ephemeral technologies based on temporal forgetting can assuage the anxieties of an atomized time in which one's past becomes one's present, an escape from the dominant orientation of persistence and remembering. This aligns with the notions of Han, who declares that contemporary technologies have informed our present and its discontinuous time, in which events are not interlinked through narrative time but exist as points that can be recalled at random [55]. As writer Susan Dominus notes,

> Facebook makes contact so casual that it allows people to leapfrog back instantly to a former you, one you thought you had left behind—maybe one you had worked hard to put firmly in the past. [35]

The value, then, of temporal forgetting is the removal of the former you, predicated on narrative time. Such technologies present a more workable solution than the inchoate musings of former Google CEO Eric Schmidt: "Every young person one day will be entitled automatically to change his or her name upon reaching adulthood in order to disown youthful hijinks stored on their friends' social media sites" [15].

In research on temporal forgetting, Koychev discussed the algorithmic process of "gradual forgetting" in which irrelevant information is gradually removed through the calculation of occurrence and significance over time [73]. Gurrin et al. consider "temporal forgetting" in robots by reducing the probability of recall over time [54]. In this case, such a design proposition involves mapping human memory features onto robotic memory to provide a "forgetting view," an initial archival view of data that forgets over time. Dodge and Kitchin discussed forgetting within lifelogging systems, suggesting the implementation of forgetting over time [34] while Jones suggests a system in which old information fades over time but with a caveat—"Invisible items remain searchable and can easily be returned to a state of visibility" [64, p.53]. Here, Jones calls for temporal forgetting through systems design according to the logic of performative forgetting: information gradually fades over time—until it is needed again.

4.4 Spatial forgetting

In memory research, spatial cues can influence memory retrieval. Returning to the scene of a memory can trigger remembrance—see, for instance, Proust's encounter with familiar uneven paving stones [95]. Spatial cues can be transposed on forgetting practices, both physically and digitally. In physical space, information can be geofenced within a virtual perimeter—to retrieve the information, one must travel to the space itself, or, otherwise, forgo remembrance. Such a system was proposed by Singhal et al. with family heirlooms having specific "data destinations" that would need to be traveled to [106]. This practice would require intention and effort, making remembrance something not "instantaneously accessible" [106, p.10]. By this logic, forgetting has a similar spatial quality, a partial forgetting practice whereby individuals forget information that can then only be brought back from the past by intentional travel. Such a system would combine Schacter's forgetting forms of blocking (*it's on the tip of my tongue...*) and absent-mindedness (*where did I put that information?*) [103].

Spatial cues can also be fully digital, in which information is placed in circumscribed digital spaces—a digital shoebox [101] or storage locker [19]. In HCI research, spatial forgetting is often connected with information's salience, as information is placed in a particular "room" according to its value or prominence. For van den Hoven et al., systems should be designed to forget through "reduc[ing] the salience of certain information" [119, p.7]. Research on social media has noted the importance of the reduction of post salience for curation or self-presentation purposes [24, 62, 134]. Personal information management research has also noted salience as a significant systems design strategy (e.g., [11, 129]). Such Goffmanesque back-staging of information may inspire forgetting,

as information moves spatially from the digital drawing room to the digital anteroom. These considerations form the backbone of information lifecycle management (ILM), a practice that is similar to "how paper records eventually become consigned to large warehouses in rural areas" [12, p.3]. As digital information becomes less relevant, it is moved to less accessible digital storage elsewhere—out of sight and out of mind (but still existent) [70]. Consider a suggestion for "inactivity-based withdrawal," a feature whereby old content can be withdrawn when it is not generating new activity [84]. In this suggestion, though, one can imagine a scenario in which one's embarrassing content continues to persist based on undesired engagement.

The environmental context of a digital space can also lead to forgetting. In the same way that noise in an environment can interfere with transmission, research has investigated the "flooding" and "manipulation" [12, 127] of digital environments to support forgetting. Consider Bishop et al., who investigate a "return to obscurity" through techniques such as making information more challenging to find [12, p.2]. They provide the example of online reputation management services like reputation.com that can shift the ranking of online content, reducing the perceptibility of unwanted information. Bishop et al. argue that pure forgetting is often impossible—one has a better chance of forgetting "not by deleting information but by obfuscating it" [12, p.1]. Other research has discussed "practical obscurity" where individuals divide personal information between multiple sites, making it hard to find [112]. Elsewhere, Bowen et al. discuss the creation of decoy documents [16], a "deception technique" [136] that can reduce the salience of given information. In these cases, spatial forgetting is undertaken when other forms of forgetting might be impossible, such as when an embarrassing photograph compromises your job security [12]. Here, forgetting is an active practice, in which the individual lays the groundwork for social forgetting through the introduction of additional information, not the deletion of initial information.

4.5 Visual forgetting

Through systems design, *visual forgetting* makes the very act of forgetting something that can be seen, and, therefore, understood as occurring. This design practice takes its inspiration from the physical world. Within HCI and CSCW, researchers noted the materiality of physical objects and their change over time. For instance, researchers investigated the importance of patina, a physical change in an object over time that often contributes to the emotional or symbolic value of an heirloom (e.g., [52, 89]). For Odom et al., a physical patina on the wood grain of their algorithmic digital music player created an aliveness, a feeling that the artifact was expressing itself, "slowly ag[ing] alongside its owner" over time [88]. In their work at the intersection of personal information management and HCI, Vitale et al. consider the design dimension of the patina as a way of visualizing the "temporal aspects of data" [124]. Materially, a patina can add or subtract: an oxide layer atop a surface or a corrosion, as when chloride eats away at bronze. As such, a patina can be accumulative or destructive. In Vitale et al., their "Patina" design represents the age of a folder based on interactions over time in the form of a visual spiral [124]—speaking more to accumulation and less to decay, forgoing the term's potential associations with visual absence.

Researchers have questioned whether such natural and physical displays of change can be adapted to digital technologies (e.g., [48, 100]), an adaptation that may modify and complicate signification and meaning [58]. For instance, Cheon and Su questioned how fragility can be conveyed in digital artifacts [22]. For Gulotta et al., the answer was to portray fragility aesthetically, with digital data "fading" with each new encounter [52]. This form of unnatural, digital decay was designed into two systems. In the first system, BitLogic, photographs decay from clear images into digital pixels over time. In the second system, DataFade, photographs change through three different digital representations of natural processes of decay: 1) weather—users give their zip code, rainy days make photographs fade over time; 2) use—photographs fade based on how many times they are

viewed; and 3) time—photographs decay "at a steady rate" over time [52]. In this research, physical processes of decay were mimicked aesthetically through digital processes and a user could visualize information being forgotten over time. Participants in the study were split: while some considered this process an "opportunity for reflection" on states of change and forgetting, others considered it a digital imposition, something that detracted from their meaningful artifacts [52, p.1818].

Such visualized forgetting plays with previous concepts of temporal and performative forgetting while taking aesthetic considerations from the physical world. Xu et al. suggest a platform like Snapchat could implement visualized forgetting, blurring expired snaps instead of deleting them, to retain moments of connection over time while erasing the content of those moments [135]. Such a design is a half-step into forgetting, in which explicit information is forgotten, but an emotional bond is retained through its visualized presence—a feeling of connection remains. Similar in its feeling of connection through affective visual forgetting, Li et al. visualized portraits of COVID-19 victims that went uncounted in official statistics as digital information that fades upon contact with a user's cursor, making a visual record of death while highlighting a process of collective forgetting [75]. The digital information, however, reconstitutes itself after a period of time to reform the portraits and begin the process of remembering and forgetting again.

4.6 Unintentional forgetting

The sections above investigate intentional acts of forgetting, as researchers investigate the forgetting practices of users or develop systems to facilitate forgetting. Here, we'd like to consider *unintentional forgetting*, forgetting practices that were unintended by users, systems, their designers, or some combination of all three. The loss of information is "part of everyday life" for individuals, and these losses are not always (or, even, often) deliberate [51]. Jones and Teevan suggest the prevalence of unintentional forgetting has led to an attitude of "radical ephemeralism": "By now many people tend to view disk crashes, computer viruses, and media obsolescence with a certain sense of inevitability" [64, p.60]. In these cases, no one is at fault, and yet, forgetting occurs. For instance, when systems go into disrepair, they can be maintained [63] or, otherwise, forgotten. Changes in media format can make information inaccessible [51, 91]. Per Blanchette and Johnson, "When new technology is accommodating, data endures, and it takes an intentional act to delete it, whereas when new technology is not accommodating, data may become effectively unusable" [13, 3]. In thinking with Blanchette and Johnson (and the hegemonic practice of remembering), technology that is "not accommodating" can lead to unplanned obsolescence and breakdown. However, even with active maintenance, unintentional forgetting can follow. The social networking site MySpace lost all its data from before 2016 due to server migration. Per MySpace: "any photos, videos, and audio files [from 2003-2016] (...) may no longer be available (...) We apologize for the inconvenience" [61]. In the innocuity of such a statement was the loss of tens of millions of songs, photos, and posts, a stark example that corporations are often mediators for personal retention, for better or worse.

Other moments of unintentional forgetting have been noted by researchers. Moments of accidental deletion can lead to permanent forgetting, as in Kirk et al., when an inexperienced user of a new family archive system may disrupt the curated collection [69]. Social media can lead to "retrieval-induced" forgetting, a form of forgetting in which sharing on social media benefits one's memory of those things shared, at the expense of things that go unshared [39, 110]. Field studies within personal information management have noted that individuals tend to forget where information is stored and entire categories of information they have saved [17, 80]. In such cases, retention can create unintentional forgetting: an "infinite basement" [65] of data can inspire an overwhelming scenario in which even if everything is in its place, nothing can be found [40]. For instance, Whittaker et al. showed that nearly 40% of digital images could not be retrieved in a family

collection when asked to find an image by memorable event [130]. In Whittaker et al.'s research, one can hear the echo of the author and poet Enzensberger: "Filed, that is, forgotten" [114].

5 WRITING DIARY WITH WATER—A DESIGN FICTION/IMPERATIVE

Bringing the sections of this work together: in our contemporary moment, we have a persistence by default design logic that frames forgetting as an undesirable practice and one that can be mitigated, in part, thanks to the decreasing cost of storage, the rise of cloud computing, and the use of corporate systems as massive repositories for personal data. Through the design of systems, we design ways of being [133], and these ways of being act out into the world—indiscriminate retention has social, moral, political, and environmental issues and obscures the significance of forgetting as a necessary component of remembering,

> [Forgetting] takes on another meaning as soon as one perceives it as a component of memory itself. (...) Remembering or forgetting is doing gardener's work, selecting, pruning. [2, p.15-17]

In considering the above, this paper considers contemporary research that investigates forgetting. We note that this research, while often compelling and significant, tends to consider forgetting through a persistence by default design logic. In doing so, forgetting as a practice is often performative—something undertaken for show. This performative forgetting decreases the salience of given information for a given user but does not necessarily address the social, moral, political, and environmental issues noted above: data is still retained, just out of sight and potentially out of mind for certain individuals. We also take into account the complications of forgetting as a practice: how is forgetting perceived socially, who is doing the forgetting, and why are they doing it? These questions often take an ethical shape: what separates the desires of an adult still tied to online records of juvenile delinquency from the business that has established retention periods for corporate activity [46]?

In his own design fiction, the author Loetscher suggested the deletion of all electronic data at the turn of the new millennium, a global event to counteract the accumulation of excessive data [77, 126]. This imagined act was a post hoc practice—that which had been remembered was to be forgotten. Taking a different approach, Chinese contemporary artist Song Dong's work *Writing Diary with Water* (see: Figure 1) embeds the act of forgetting into the work's essence, a pre hoc practice—that which could have been remembered never was. *Writing Diary with Water* comprises four photographs of a performance in action: the writing of a diary page with water on stone. As the calligraphic brush begins a new line, the line above dissipates. The photographs never capture the nature of the temporary diary entry. Instead, they highlight process over outcome. Song Dong's work is at once a meditation on impermanence, a reorientation of what is valued, and a sublime strategy—if the traditional diary leaves one vulnerable to disclosure and context collapse, the water diary allows for the process of putting one's thoughts into words without the associated risks of retention [125]. In his own words, "I focused on the end which is Nothing" [76].

Thinking at the intersection of technology and society, Song Dong's work can be a way forward for forgetting research. With *Writing Diary with Water*, we can imagine an alternative future in which forgetting takes its place as an integral and defined (not just implied) component of technologically-mediated memory. Here, we think through three features of this artwork as considerations for the future design of forgetting systems.

First, a consideration for historic and significant artifacts and practices. As noted by boyd, contemporary technologies make our present modes of retention possible [105]. HCI and CSCW research on forgetting often takes the contemporary moment as its starting point, building on the momentum and ways of being represented within these technologies. Song Dong takes as his

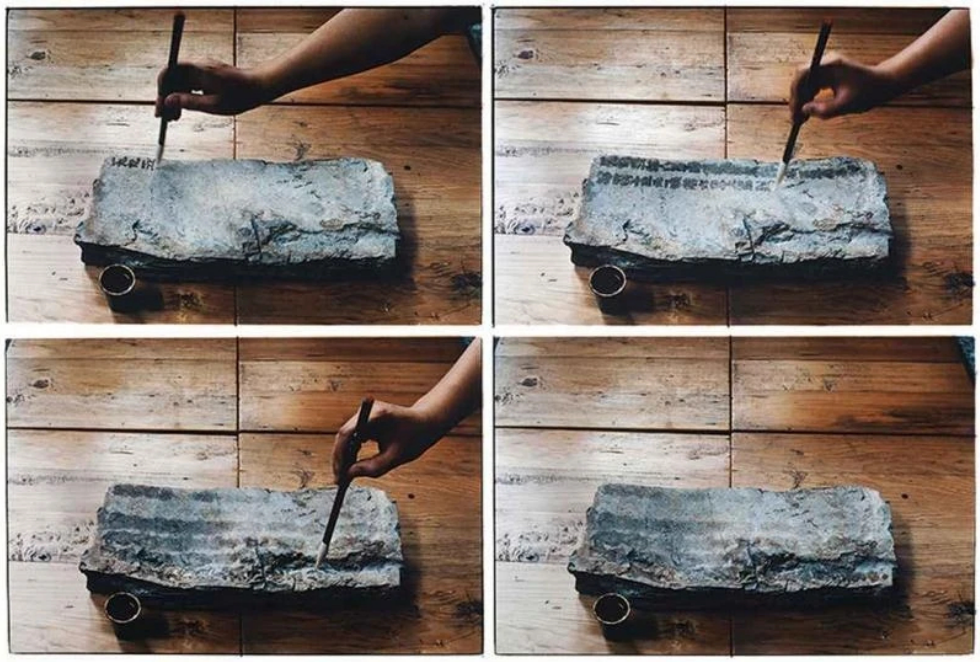

Fig. 1. Song Dong, *Writing Diary with Water*, 1995

starting point traditional Chinese artistic practice. From etchings on ceramic with cinnabarite to Zhong Yao's development of regular script that matured over hundreds of years, Chinese calligraphic practices have a storied history that has informed ways of being for millennia. Song Dong's work is both informed by and subverts this history by emphasizing that which is often de-emphasized: the impermanence of the written word. Forgetting research and designs should take as their inspiration not present artifacts and capabilities but historic artifacts, capabilities, and ways of being. How do these disrupt or otherwise confirm our present designs and thoughts?

For instance, ars memoriae was an ancient mnemonic technique to aid in remembrance and one with a specific focus on internal spatialization. Within this art, each mental image has its own specific location within one's mind—an internally navigable act of remembrance built upon spatial associations. Per Cicero, the space in one's mind is the writing tablet, and each mental image is a letter or word that is written down [27]. What can we take from Cicero and Plato (or, for that matter, Kant, who declared "we know as much as we have memorized" [126, p.59])? Do we agree with Ricoeur, who called ars memoriae "an outrageous denial of forgetfulness" [97, p.66]? How could the history of ars memoriae influence our understanding of and design for forgetting? Or consider the externalization of memory in the form of mnemotechnics (mnemonic techniques, memory aids): "tools that enable memory to be stored externally" [44, p.194], such as alphabets, paintings, and poems. Within Clark and Chalmers' extended mind hypothesis, they term the use of mnemotechnics "active externalism," in which nonbiological objects—artifacts, media, technologies, environments—work with the biological to produce cognitive life ([28], see also [113]). How have these mnemotechnics evolved over time, and how has that evolution impeded kinds of forgetting? How can we emphasize that which has been de-emphasized?

Second, the need for user control and agency. In *Writing Diary with Water*, it is Song Dong who decides both how much is retained and who retains that which remains. As noted above, by their

nature, systems delimit a scope of possibility—one cannot keep a friend's photo posted on Snapchat (until one does [32]). Systems delimit according to the intentions of their designers: if forgetting is not considered, or is considered something to impede, the agency found in Song Dong's work goes missing. Similarly, it is important to remember that giving control over remembering to automated systems is also giving control over forgetting to automated systems [94].

In remembering and forgetting research, there exists a tension between automation and user control. Jones and Teevan suggest personal curation and organization are "easy to postpone and avoid altogether" and may be better suited for automatic processes [64, p.17]. Cavalcanti et al. concur: individuals are "unmotivated to invest personal time and effort into manually organizing their collections; they require automated methods for managing these media libraries" [20, p.3]. Other work puts forth systems to automatically organize personal information (e.g., [68, 74]). On the other side of the spectrum, Thomas et al. highlight how automated processes of personal curation can hinder "personal reflection" [118]. Mondal and Messias discuss the personal, complex, and "sometimes contradictory" desires of the retention and deletion of older content [84]. Here, such contradictions would make automation difficult, if not impossible. As with the "crude binary" of existence and non-existence [102], automation and non-automation are tempered by research in search of a middle-ground [49, 53, 66]. In our work, we want to emphasize the need for user agency in deciding what to retain and who retains. As systems have become active participants in shaping attention, it is necessary for this participation to be at the dynamic and changing behest of individuals, much as Song Dong chooses what materials to use in his diary-making, where to position his camera, when to take a photo, and how to arrange these photos.

Third, centering forgetting as an expressive act. In Song Dong's work, forgetting was a pre hoc intention built into the practice itself. Diary writing is a practice that requires discipline: it should be undertaken daily at a set time so that there is a consistent record of one's thoughts and emotions to consult and reflect upon. By using water instead of ink, Song Dong does away with this possibility. This near-immediate erasure of effort and record suggests Song Dong has committed himself to the *process* of reflection and writing as acts in and of themselves, without the necessity of outcome or retention.

This conclusion is complicated by Song Dong's also premeditated photographs of the event. By introducing this second practice, Song Dong presents for posterity his commitment to process in one sense while producing an outcome in another sense. Put another way, the photograph is an outcome of a process without its own outcome, a layer of contemporary mediated memory atop an ancient one. This does not negate his initial desire to focus on process over retention, though, and instead points to the possibilities of designing for forgetting *expressively*. Here, we can consider the auto-destructive artist Gustav Metzger, who said that "auto-destructive art was never merely destructive. Destroy a canvas and you create shapes" [122]. In this way, forgetting can be an expressive practice with its own qualities that afford distinct possibilities. We can also consider work that makes the invisible visible: take, for instance, Viny and Desjardins' Desktop Odometer, a device that tracks the miles between a user's location and the servers where their requested information resides [123]. Here, the otherwise invisible act of digital information movement from somewhere takes a visible form. One can imagine a forgetting system that takes a similar shape: a running tally of deleted data in bytes that accounts for data center energy consumption and the energy saved. In such a system, forgetting is a process in and of itself that also has a visible and expressive outcome.

ADDENDUM

Aligning with Song Dong, we re-considered our materials at hand: the conference paper. Initially, this paper was designed to delete itself within the archive over time. We developed a script to

trouble the idea of archival stasis and further consider process over outcome—see Appendix A for the code in its entirety[1]. The code imagines a 13-page conference paper that self-deletes within the archive. Each page of the paper would be accessible only through QR codes, each page with its own QR code—see Appendix B for an example of a QR code page. Each QR code leads the reader to a hosted version of its respective page that is itself run through a virtual machine and script that randomly deletes one page every 20 to 40 days. This script would run for 520 days or until all pages are deleted. In concept, the full paper would be deleted, one random page at a time, within an average of 318.5 days.[2] If this code was run on this paper, within a year of its publishing, this work and its taxonomy of forgetting research in HCI and CSCW would themselves be erased.

The paper-deleting script was to act as a speculative method by which to explore the practice of forgetting. If a paper deletes itself in the archive, the benefit of writing the paper shifts—away from an end product to be retained and cited and towards a processual document to be appreciated in the act of writing. In thinking with Eco, while what has been "forgotten" cannot be retrieved, how it was forgotten remains, much as Song Dong's photographs retain his process. In this way, the broken QR code presents an opportunity for reflection on the practice of forgetting—the reader is given the chance to interpret absence and consider its value. What is missing, or what has been forgotten? What remains?

6 CONCLUSION

By way of conclusion: HCI and CSCW, as well as the information sciences more generally, are often concerned with "productive actions"—preservation, access, retention [60]. This work has argued that forgetting is an essential part of remembering—in our present moment of persistence by default, we must remember to forget. We have presented a taxonomy of forgetting within HCI and CSCW and considered research thus far as primarily being concerned with performative forgetting, which is to say, a negotiated and partial forgetting without the full commitment to an immediate and total loss of information. In this way, even research pertaining to forgetting seems suspicious of forgetting as a practice. However, we argue we should embrace forgetting, now more than ever, while also taking into account the tensions that forgetting surfaces: how is forgetting perceived socially, who is forgetting and why, and who has the power to be forgotten and who does not?

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[1]This code was co-conceived and entirely written in its final form by James M. Zumel Dumlao
[2]That is, unless a reader downloads each page individually, in intentional and oppositional acts. For a further discussion of authorial intent and the desire to retain, see the discussion on Gibson's *Agrippa (A Book of the Dead)*

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A CODE FOR FORGETTING

```
import os
import time
import random

def delete_webpage_after_random_mins(file_path):
    # Switch part in quotes for own directory path
    server_path = "[REDACTED]" + file_path

    # Generate a random number of days between 20 and 40, so the range for all files to be deleted is between 260 and 520 days
    random_days = random.randint(20, 40)

    # Calculate the total seconds for the random number of years
    total_seconds = random_days * 24 * 60 * 60

    # Wait for the calculated duration
    time.sleep(total_seconds)

    # Print how long the program will sleep
print(f"Deletion in {random_days} days.")

    try:
        os.remove(server_path)
        # Print the file deletion message
        print(f"The file {server_path} has been deleted after {random_days} days.")
    except FileNotFoundError:
        # Print file not found message
        print(f"The file {server_path} was not found.")
    except Exception as e:
        # Print general error message
        print(f"An error occurred: {e}")

# Put filenames into a list
files_to_delete = []
for i in range(1, 13):
    filename = f"Page {i}.pdf"
    files_to_delete.append(filename)
# Delete files in random order until no more files are left
while len(files_to_delete) > 0:
```

```
39      file_path = random.choice(files_to_delete) # Pick a random
            file from the list
40
41      delete_webpage_after_random_mins(file_path) # Delete the
            file after a random number of mins
42
43      # Remove file_path from files_to_delete
44      files_to_delete.remove(file_path)
45      # Print remaining files message
46      print(f"Remaining␣files:␣{files_to_delete}")
47
48  # After while loop is done (no more files to delete), print
        message that all files have been deleted
49  print("All␣files␣have␣been␣deleted.")
```

B EXAMPLE OF A QR CODE PAGE