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ARTICLE

Exhibiting Digital Disappearance

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Abstract

Museums must prepare for a post-digital era in which the cultural record will increasingly disappear without leaving stable objects behind. Contemporary history and cultural anthropology are now written through digital infrastructures, yet born-digital heritage is unstable, uneven, and often lost before its value can be recognised. Web archives aim to combat this forgetting, but they operate in a digital realm where what survives is partial and transformed through capture. This raises a museum question as much as an archival one: how can museum's exhibit cultural memory when the object itself may have disappeared and never been tangible? Using the Digital Ghosts exhibition as an example, this article explores how museums can make digital decay visible, spatial, tactile, and affective. The exhibition translated web archive metadata into interactive visualisations, data physicalisation, and embodied encounters with decay and uncertainty. As the lifecycles and nature of cultural objects have changed, innovation in museums is not just a matter of superficial immersion or modernisation. Museums will need to move beyond valuing only what survives and develop methods for exhibiting what preservation misses, what disappearance feels like, and why absence itself has become part of cultural heritage.

Keywords: data visualisation; digital heritage; museums; postdigital; web archives

Museums have long relied on the authority of material survival. As a memory institution dedicated to preservation and care, the museum's value proposition used to depend on the presence of things. Whether artefacts, artworks, documents, specimens, or buildings, objects used to be the link between scholarship and audiences. Born-digital heritage has unsettled this logic.

1. The increasingly unstable objects in the post-digital age

The shift is enormous and unstoppable: around a quarter of the world's stored information was digital in 2000, but by 2013, estimates put it at over 98 percent.[1] Even more worryingly, we have been losing this information as invisibly as we created it.[2] The digital footprint of our contemporary culture is the web, but contrary to common misconception, not

[1] Mayer-Schönberger and Cukier 2013, 8, 9.
[2] Harlung 2025, 15.

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everything stays on it. In one large-scale study of 10 million webpages, more than 90 percent had disappeared within twelve years, and the average lifespan of a webpage was only three years.[3] The web is dynamic, constantly rewritten, and more frequently lost than saved.

Web preservation efforts are as old as the internet itself, and web archives attempt to stabilise this flux through a combination of automated crawling and heroic human curators.[4] The result is always fragmented and approximate: what survives is only a ghost of our original, diverse online life. Technical reach, legal frameworks, institutional priorities and finances, platform power, access restrictions, and the dynamic nature of the live web shape what we can save.[5] This causes a paradox of digital preservation: we live with an abundance and a lack of online data at the same time.[6]

A web archive is like rehydrated instant coffee: reconstructed rather than restored, with something inevitably missing. It's a taxidermy lion that is recognisable but will never roar at you. This problem raises as much a museum question as an archival one. If more and more cultural life happens through digital infrastructures, how can museums help their public understand what digital preservation can and cannot do for our memory? Moving from rubbish to canon used to rely on the delayed attribution of value to objects, but the lifecycles of digital artefacts have accelerated and blurred.[7] We can no longer reliably follow the cultural biographies and social lives of things as Igor Kopytoff and Arjun Appadurai famously proposed in the 1986 book *The Social Life of Things*, because not only their value or meaning but the objects themselves may transform or disappear along the way.[8]

How can museum's exhibit the uncertainty and absence inherent in born-digital objects? How can a museum exhibit something that may no longer exist, or exists only as a partial capture, a timestamp, a dead link, or a record in a metadata table?

The instability of the object is not a new concept in museology. The field has always dealt with mitigating loss; the surviving artefact has never been absolute. The core idea behind critical heritage studies is that heritage is "inevitably a realm of ideas rather than a collection of things," says English Archaeologist John Carman.[9] "There is, really, no such thing as heritage," Australian museum scholar Laurajane Smith adds in her foundational book on the discursive nature of heritage.[10] While she meant that heritage is a practice, her observation also unsettles the tangible-intangible divide. Carman calls this binary a "shibboleth and a myth we need to move away from," deeming it an unnecessary distinction.[11]

What is changing now is the scale of the disjoint and the acceleration of obsolescence. This rapid transformation puts both preservation and interpretability of the object at risk. Among its many definitions, post-digital can be understood as living, creating, and consuming under conditions in which the digital is becoming mundane rather than the shiny

[3] Agata et al. 2014, 464.
[4] For web archive history, see Milligan 2024.
[5] See Brügger and Milligan 2019.
[6] See Nanni 2019.
[7] See Carman 2002; Thompson 1979.
[8] Appadurai 1986; Kopytoff 1986.
[9] Carman 2009, 196.
[10] Smith 2006, 11.
[11] Carman 2009, 200.

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new thing.[12] It seamlessly blends our physical, everyday life with our online and datafied activities, eroding the strict binary between analogue and digital into a shapeless, hybrid middle ground that the German art critic Florian Cramer illustrated with the viral photo of the man typing on a mechanical typewriter in a park.[13]

The same argument returns in museum studies. British anthropologist Haidy Geismar favours understanding digital museum objects as a trajectory of materiality, linking information to material, systems to structures, knowledge to form.[14] Post-digital heritage discourse should therefore also embrace movement between the extremities of online and offline, digital and analogue, preservation and loss, certainty and uncertainty, reality and simulacrum. This is both an ontological and epistemological problem: how do we interpret something that may never have existed in its current form—the reborn digital?

2. Reborn digital: Born-digital objects in museums

Exhibiting born-digital objects goes beyond the classical museological problem of selection and interpretation because the object itself is temporally contingent and, crucially, transformed by capture. In the web archive discourse, internet historian Niels Brügger famously distinguished between digitised (having an analogue original), born-digital (the digital is the original), and reborn-digital materials, the latter changing significantly through the collection process.[15] If born-digital is the lion freely roaming the savannas, reborn-digital is the stuffed version with glass eyes standing still in the Natural History Museum.

Digital culture theorist Chiara Zuanni links reborn-digital materials to museums, arguing that this process is akin to musealisation, which transforms "things" into "museum objects."[16] Unfortunately, she reaches a pessimistic conclusion: if musealising a born-digital object necessarily transforms its materiality, preserving an unchanged original is impossible. In my view, accepting this transformation, rather than chasing restoration, allows museums to preserve and interpret a reborn-digital object, creating new curatorial meanings and narratives. While Zuanni leaves the identification of specific curatorial practices open, she acknowledges that museums already deal with digital objects across art, history, anthropology, and science. Yet shared workflows and theoretical positions are still emerging. Conservation scholarship on digital art has already developed strategies for managing technological and material instability, and recent work extends these questions to the broader range of born-digital objects entering museum collections.[17]

However, existing responses to the instability of born-digital objects, such as the V&A's framework, have largely been operational, focusing on acquisition, preservation, documentation, infrastructure and institutional decision-making.[18] The relatively sparse theoretical positions call for embracing more experimental collecting practices that better match the fluidity of born-digital objects.[19] I fully agree with Nicôle Meehan, who engages absence

[12] For more on post-digital definitions, see Cramer 2015.
[13] Cramer 2015, 12.
[14] Geismar 2018.
[15] Brügger 2016.
[16] For musealisation process see Desvallées and Mairesse 2010; Zuanni 2021.
[17] Falcão and Ensom 2019.
[18] Arrigoni et al. 2022.
[19] See Arrigoni and McKim 2024; Talley and Gardner 2023. For theorising data-driven objects through the long-standing history of data-driven logics in design, see Talley 2026.

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itself, arguing that transparency about gaps and uncertainty can turn what is missing into a form of presence.[20]

If the metamorphosis of born-digital into reborn-digital material is inevitable, the museum object need not hide what was lost or changed in the process. I suggest taking this rebirth even further, towards the idea of the reincarnated digital. The partial capture can be accepted as a simulacrum without an original: its absences, fragments, and transformations become part of the object, while its distance from what once existed creates interpretative flexibility for exhibition.

Rather than forcing the reconstruction of an imaginary digital twin, museums can use these traces to give the object another life through a new encounter. Geismar describes these moments of remediation in which knowledge and meaning itself are produced.[21] If, in Bruno Latour and Adam Lowe's terms, reproduction allows an original's aura to migrate, I suggest that digital reincarnation can create a new aura around the transformed object, grounded in what survives, what has disappeared, and how these conditions become perceptible.[22]

Whether we like it or not, we must learn to deal with these conditions, making it the museological equivalent of "when life gives you lemons, make lemonade." Nicholas Thomas, in his seminal work about the new museum age, referred to encountering physical museum objects as "the conjuncture of intimate actuality."[23] To stage such intimacy, museums can make absence visible, spatial, tactile, and affective, inverting digitisation without pretending to repair it. Through data and creativity, they can showcase digital loss as a current and acute condition of cultural memory. Museums might be able to keep the cake and eat it by staging disappearance through interpretation that enables embodiment and interaction—as when an exhibit titled *Digital Ghosts* accepted these conditions and offered a possible solution.[24]

3. Digital Ghosts as a public encounter with absence

Archived web materials are a particularly revealing case of reborn-digital transformation because they preserve neither a stable original nor a complete surrogate, but partial and technically mediated traces of a well-known but ever-changing online environment. Artists and memory institutions have already experimented with bringing such traces into exhibition space. At the dawn of the internet, Alan Rath's *World Wide Web, 1997: 2 Terabytes in 63 Inches* translated an early collection into a tower of CRT monitors displaying archived pages. Originally exhibited at the Library of Congress, the sculpture pinpointed the link between the analogue and digital by giving the records a physical body.[25] Richard Vijgen's Deleted City took this translation in a different direction.[26] It reconstructed GeoCities, a popular 1990s web-hosting community closed by Yahoo! in 2009, from its archived elements—or "digital ruins," as Milligan puts it—, as an interactive, navigable digital city, reimporting the physical, spatial logic into the digital records.[27]

[20] Meehan 2026.
[21] Geismar 2018.
[22] Cf. Latour and Lowe 2011.
[23] Thomas 2016, 51.
[24] For discussing the impact of embodiment and interaction on heritage affect see Kocsis 2026a.
[25] For the discussion of the surrounding historical scene, see Milligan 2024, 196–7; Rath 1997.
[26] Vijgen 2012.
[27] Milligan 2017, 137.

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Digital Ghosts also highlighted the fluidity between digital collections data and embodied experience, but shifted the focus from displaying archived web content to the conditions of its survival. It treated both preservation and curation as transformative processes, making its gaps, decay, and disappearance part of the object's new life. It was a practice-based research project and exhibition at Inspace Gallery, Edinburgh (5–15 November 2025), built from metadata of the yet-unpublished *Scotland on the Internet* [working title] web archive collection, hand-curated by the National Library of Scotland over the previous decade.[28] At the time of the research, the growing collection contained 87,000 records describing Scottish culture in the Williamsian sense of "the whole way of life": businesses, public and non-profit organisations, schools, artists, food, religions, civil organisations, politics, and news.[29] The unstructured metadata contained URLs, capture dates, thematic categories, and contextual fields, and during the research project, it was enriched with data derived from UK Web Archive (UKWA) metadata and the Internet Archive's Wayback Machine, such as first- and last-seen dates and inferred geographic or content information.

Despite their importance as imperfect repositories of our modern life, web archives notoriously struggle with access and usability.[30] The exhibition therefore aimed to offer visitors a tactile museum experience rather than a spreadsheet of metadata. Web archives are difficult to communicate because their key conditions are often invisible, overly technical or—to be honest—simply boring. Terms such as crawling, capture, legal deposit, metadata enrichment, and link rot are rightfully missing from many museum visitors' vocabularies.

These infrastructural processes are usually encountered through tedious interfaces, such as search boxes or catalogue dropdowns, not in an engaging museum environment. So the exhibition used conceptually accessible metaphors, giving the public a tangible route into archival complexity. Analogies, such as falling, fading, or playing with light and dark, made these processes legible, while embodiment and interaction let visitors feel the web's temporal life and the incompleteness of preservation.

The exhibition had three goals: raise awareness of the scale of data decay, demonstrate the gaps and absences in collections, and explore how design-led approaches can improve interactions between visitors and collections in archives and museums. To do so, it used creative, tactile forms of data visualisation and physicalisation to communicate the instability of born-digital heritage.

Three interactive visualisations, one data physicalisation, and one geospatial visualisation offered a way to encounter web decay at the museum. Visitors could walk through time, trace sites falling out of the live web, explore public discourse through touch, observe uneven geographic representation, and witness data become physical marks on canvas through light exposure. Together, the works aimed to help visitors recognise the limits of finding our footprint in future museum and archive collections.

The exhibition therefore explored ways to stage a museum encounter with absence. As part of the practice-research, we worked across the full process: preparing and analysing the data, curating and producing the exhibition, but also evaluating visitors' responses and changes in web archive awareness, and documenting the design process behind the

[28] Kocsis and Kaufmann. 2025.
[29] Cf. Williams 1958.
[30] See Jaillant 2022; Talboom and Kocsis 2025.

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exhibition.[31] As project lead, I served as manager, researcher, curator, creator, and evaluator throughout, including surveying 94 of *Digital Ghosts'* 300 visitors.[32]

4. Making disappearance felt

The ghost metaphor captures the altered presence of a born-digital object: something that once existed, but now lives forward only in transformed traces, caught in the limbo of presence and absence. The exhibition sought to turn the archive into a museum, showing that what is preserved as an online record is actually just a ghost of our lived, physical life.

The commissioned centrepiece that gave the exhibition its name, *Digital Ghosts*, by Dorsey Kaufmann—co-curator and lead artist of the exhibition—championed this idea. Using UV light and cyanotype, an early photographic process, the centrepiece transformed the life and death of websites into durational exposure. Over the first week, she projected an animation showing the appearance, cataloguing in UKWA, and disappearance of links related to four sociopolitical topics—Climate Change, Civil Rights, Covid-19, and Brexit—onto cyanotype (Figure 1). In the second week, the canvases were cured and rehung as static

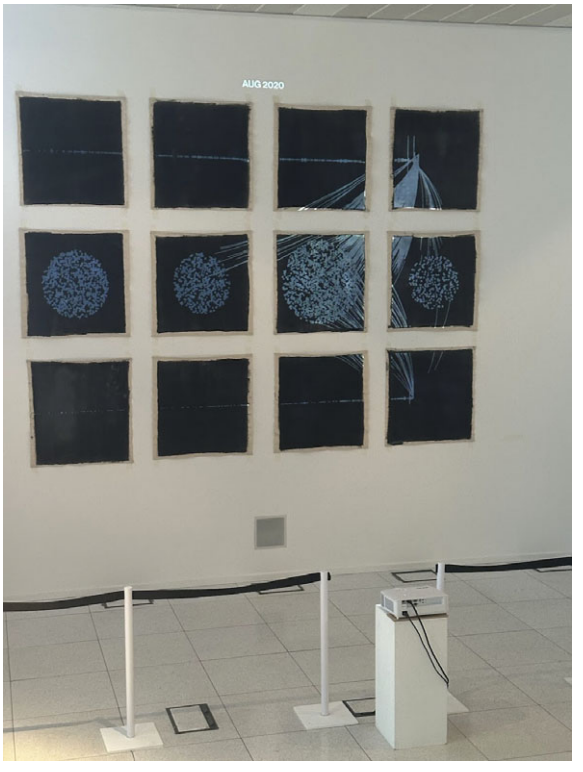


Figure 1. Digital Ghosts by Dorsey Kaufmann during the process of light exposure. Photo: Chris Scott.

[31] For the preliminary results of the visitor evaluation, see Kocsis 2026b; For the detailed design process, see Kaufmann and Kocsis 2026.

[32] See Kocsis 2026b.

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artefacts, revealing the imprint the light left behind so visitors could experience the temporality and unevenness of transitioning between the physical and the digital realms (Figure 2). Long-lived sites left stronger marks, while short-lived sites appeared only as faint prints, leaving only the skeleton of that reality.[33]

Light-writing offered a fitting metaphor for the web, as we wanted to emphasise the consequential invisibility and the digital flattening of three-dimensional reality in web archives. In this way, the cyanotype canvases became museum objects produced through disappearance and transformation. While they did not solve the web's instability, they gave it a surface that resonated with visitors. By encountering the two-way transition between the physical and digital, visitors reported understanding the process of loss and felt a form of grief and serenity.[34]

The Life and Death of Music (by Mansi Manoj and Feeling Data) made disappearance more explicitly affective (Figure 3). It focused on approximately 5,600 music-related websites in the collection, almost half of which were no longer live. Active websites floated within a rotating sphere, while those reaching the date of their last web appearance fell into a puddle below, making the accumulated loss visible. Through touch, visitors could stop the falling, filter by category, move through time, and watch genres and artists they liked appear or vanish. The personal connection between music and fans made the piece emotive, and visitors reported the strongest emotional resonance with this work.[35]

In *Sites: Surfaced or Submerged* (by Qianhui Meng and Feeling Data), visitors moved in front of a motion tracker to explore the decade-long rhythms of collecting the *Scotland on the Internet* records (Figure 4). The work showed how different topics entered the archive and whether



Figure 2. Digital Ghosts by Dorsey Kaufmann after the reveal. Photo by the author.

[33] See Kaufmann 2025. For interaction videos, visit Kocsis and Kaufmann 2025.
[34] See the details of visitor evaluation in Kocsis 2026b.
[35] Kocsis 2026b.

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Figure 3. Visitors interacting with *The Life and Death of Music* to explore the disappearance of music from the web. Photo: Chris Scott.



Figure 4. Visitors followed the motion tracker of *Sites: Surfaced or Submerged* to uncover collection bias and dynamics. Photo: Chris Scott.

the corresponding sites remained live or had disappeared into dead links. Sites still accessible on the live web appeared above the axis as the tip of an iceberg, while sites that had disappeared fell below the water. The piece also placed visitors inside the temporal logic of curation: moving through it meant moving through the curator's changing attention, highlighting the embedded human bias in archiving. It resonated most strongly with visitors with GLAM (Galleries, Libraries, Archives, and Museums) backgrounds.

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Beyond these works on embodiment and emotional connection, the exhibition also included an interactive, sociopolitical piece on COVID-19 news (*Pandemic in the Archives!* by Shuyu Zhang and Feeling Data Studio) and an animation revealing geographical bias and gaps in the collection (*Digital Coordinates* by Parker Kaufmann and Feeling Data). To make room to reflect on these gaps, we dedicated space for visitors to identify absences they noticed and curate their own web archive for the future, effectively creating their own objects for interpretation. We also accompanied the exhibition with hands-on data physicalisation workshops, helping visitors further explore the shift between digital and material.

5. Exhibiting absence in data

Exhibiting absence bears an ethical responsibility. It can be tempting to stage unearned authority and make partial data look complete through smooth interfaces, hiding the conditions under which it was produced. In cultural heritage contexts, it risks flattening ambiguity inherent to culture, and turning historically situated, institutionally shaped collections into apparently neutral information. *Digital Ghosts* actively resisted this by making incompleteness part of the encounter. Think of The Lion King: while the recent uncanny live-action lions made us cringe in our recliner seats, the original 2D animation had no trouble teaching us about the circle of life.

To avoid presenting the web archive as a complete digital twin of Scotland, the exhibition made thematic gaps, uneven coverage, temporal fragility, and curatorial bias part of the story, finding technological and artistic ways to exhibit them. In practice, these forms of absence overlap, and it is not always possible to know whether something is missing because of technical loss, curatorial decisions, collection bias, or because it was never captured or never existed. Mimi Onuoha's *Library of Missing Datasets* physical installation and accompanying digital repository make a related point by drawing attention to the various social and institutional conditions that determine what becomes data in the first place.[36]

Hence, we considered our sources "capta" rather than data, referring to information that is "taken, constructed, and interpreted rather than simply given."[37] This shifts attention from visualisation as a finished product towards scholarly inquiry, where iterative design, experimentation, and collaboration play a central role in knowledge production. Hinrichs and colleagues called these exploratory and interpretive visual outputs "sandcastles."[38]

Many criticisms in digital scholarship, whether in art history, literary studies, or the humanities broadly, consider datafication and the digital to be missing the nuance of interpretation.[39] However, I agree with Emily Pugh that this is not an either/or question, but a both/and problem: data itself can be interpretative.[40]

The high level of interpretation required and the diverse skills involved made collaboration essential to staging this encounter. For museums, post-digital heritage blurs boundaries among art, history, science, and anthropology, continuing a critique of uni-disciplinary museum practice already underway.[41] In our case, the project brought together archival

[36] Onuoha 2016.
[37] Drucker 2011, 3.
[38] Hinrichs, Forlini, and Moynihan 2019.
[39] Cf. Bishop 2018; Marche 2012.
[40] Pugh 2023.
[41] Phillips 2019.

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knowledge, data science, art, software development, and venue-specific installation expertise. This distributed process kept the exhibited pieces contextually connected to the archival conditions while transforming them into new museum objects.

Visitor responses suggest that this route worked. Pre-exhibition user testing indicated that participants generally grasped the core metaphors.[42] At the public exhibition, visitor surveys showed that many arrived with limited prior understanding of online decay, yet left saying that the exhibition had changed how they thought about digital loss and online presence. Comments described the works as engaging and emotive, and suggested that visualisation helped visitors sense the "shape" and "form" of losing online content.[43]

6. Museums as places for perceiving loss

In the post-digital future, museums will need to deal with the frequent disappearance of the intangible—a problem far removed from centuries of object-centred museological practice. This shift is not about catering to digital-native audiences, commercialising immersive experiences, or modernising through chatbots or gamification, but something at the very heart of collections. Namely, that contemporary history and cultural anthropology are written digitally, and born-digital heritage is not only immaterial but also unstable. Its disappearance often happens without drama: a domain expires, a platform closes down, a format becomes obsolete, or a page is no longer maintained. By the time the loss becomes visible, the object may already be gone or changed beyond recognition. Museums have often taught the public to value what survives, but caring for digital memory also involves designing ways for audiences to understand what preservation misses, what disappearance feels like, and why absence itself has become part of cultural heritage.

Digital Ghosts shows that museums and galleries may respond to this condition by making disappearance and transformation explicit and experienceable. Through motion, touch, light, mapping, and material exposure, the exhibition translated unstructured web archive metadata into encounters with decay and uncertainty. If the web documents our current social, political, and cultural life, then digital decay is not only a problem for present archivists or future historians. It also concerns how communities understand the fragility of their own contemporary records. Hence, the museum becomes a contact zone where this fragility can be made public and tangibly encountered—even if only temporarily. Ironically, staging these encounters means the exhibition itself is also caught in the same cycle: its digital objects depend on technologies that cannot escape obsolescence, so they too may eventually need another reincarnation to survive. It's the post-digital circle of life.

Dr Andrea Kocsis is a Chancellor's Fellow in Humanities Informatics whose research sits at the intersection of digital humanities, cultural heritage, and computational social science. Her recent work focuses particularly on how user-centred design and creative practice can make digital collections and web archives more accessible, usable, and engaging. She holds a PhD in Heritage Studies from the University of Cambridge and has held research positions at The National Archives UK, the National Library of Scotland, and Cambridge University Library. She is the lead investigator on the BA/Leverhulme Small Grant project *Digital Ghosts – Exploring Scotland's Heritage on the Web* (2025–26).

[42] See the pre-user testing in Kaufmann and Kocsis 2026.
[43] See the survey evaluation in Kocsis 2026b.

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