Sustainability Fever:

On Digital Preservation and the Notion of New Ecological Mindsets

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Fredrik Ringholm (11693363)

fredrik.ringholm@gmail.com

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UNIVERSITY OF AMSTERDAM

Abstract

When it comes to addressing climate change, archives persist in treating symptoms instead of engaging underlying causes. This is an urgent concern for archival institutions seeking to improve the environmental sustainability of their digital preservation efforts. This thesis sets out to problematise and explore the relation between environmental sustainability and digital preservation. Framing digital preservation as an ICT-supported process of maintaining the reliability and accessibility of information in the (indefinite) long-term requires accounting for the ways in which it is contributing to climate change in ways that threaten its own longevity. By continuously reinforcing an ideology of efficiency, techno-optimism and progress, archives undermine their own sustainability ambitions. The research presented here begins dismantling these components through discussion of the influential article "Toward Environmentally Sustainable Digital Preservation" (Pendergrass et al. 2019), and contemplates the potential of a new ecological mindset based on the lessons of alternative narratives (repair, decay and slow media). Finally, it tests the fruits of this exploration against the case of the NDSA Levels of Digital Preservation—proposing ways of extending their model to incorporate an ecological mindset. From this project of imagining ecological paths forward emerges the argument that digital preservation professionals need to proceed forward at a more cautionary pace, slowing down to allow for an engagement with the cultural values of their work.

Key words: archives, climate change, digital preservation, ecological mindset, environmental sustainability, paradigm shift.

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> The darkness of ecological awareness is the darkness of noir, which is a strange loop: the detective is a criminal. In a strong version of noir the narrator is implicated in the story: two levels that normally don't cross, that some believe structurally can't cross. We "civilized" people, we Mesopotamians, are the narrators of our destiny. Ecological awareness is that moment at which these narrators find out that they are the tragic criminal (Morton 2016, 9).
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> Today, of course, the frightening realities of global warming and climate change pose a new threat of total and remainderless destruction. We—we archivists, we human beings—are all caught up in the dynamics of endgame (Harris 2011, 122-3).

Introduction

Anthropogenic climate change poses unprecedented challenges to contemporary societies.[1] Escalating extreme weather patterns and associated socio-economic devastation have only recently gained serious traction in international political discourse. Most significantly this is represented by the Paris Agreement, an international UN treaty which seeks to counter human-made climate change and establish "a climate neutral world" by the year 2050 (UNFCCC 2021). An ambitious goal which needs to be accomplished to limit the escalation of global temperatures to levels which still support human life. Environmental groups such as Extinction Rebellion criticise national governments for, in their view, not adopting the necessary policies to reach this goal (Extinction Rebellion Nederland n.d.). A recent UN report also suggests "the world is wildly off track," even with amendments made to the national climate plans in the last year (Vaughan 2021). This reflects the urgency of considering the environmental sustainability of practices across all sectors, as the coming decade will largely determine the success of "achieving net-zero emissions by 2050" (Amsterdam Centre for European Studies 2021). Environmental philosopher Timothy Morton suggests that humans are tragically caught in the strange loop of the anti-hero in noir fiction: by investigating climate change humanity finds itself implicated in its own potential demise. For archivists who seek to preserve and provide durable access to material, the extensive use of digital technologies for storage and access paradoxically means digital preservation contributes to the environmental and ecological threat to the longevity of both its materials and (future) users.

[1] The anthropocene is understood here and in what follows as a proposed new historical era defined by human complicity in global ecological transformations (Blasdel 2017).

One influential attempt in the realm of archives to reckon with environmental sustainability is the paper "Toward Environmentally Sustainable Digital Preservation", in which digital archivists Keith L Pendergrass and Walker Sampson, and digital librarians Tim Walsh and Laura Alagna, present a range of (already) implementable measures meant to mitigate environmental impact. Their work was awarded with the 2020 Fellows' Ernst Posner Award (Society of American Archivists 2020). Additionally, it has been well-received by practitioners as an answer to how to implement environmental sustainability in digital preservation, as seen in hopeful statements such as that by digital preservationist Barbara Sierman, that "integrating sustainable digital preservation will happen in the course of 2020" (Sierman 2020). This thesis recognizes that their work is an important contribution, but challenges how far it contributes to an ecological paradigm shift. For such a new ecological mindset in archives to develop, I argue that further socio-cultural change is needed. Without the effort to change how archives think about their role in ecologies of the future, mitigation measures risk not being enough.

MOVING BEYOND THE SYMPTOMS

As Harris' suggests, archivists may find themselves "caught up in the dynamics of endgame," (Harris 2011) but significantly, digital preservation is a project with no clear end goal in sight: "most organizations continue to strive for optimal digital preservation without evaluating whether their actions help the organization fulfil its mission. … no established metrics exist for evaluating the success of digital preservation" (Pendergrass et al. 2019, 181). Without a sense of the boundaries of sometimes massive digital heritage undertakings, the collections continue to grow exponentially, accruing immense environmental costs in the process. Considered globally this logic of accumulation will only continue to accelerate as more institutions in more nations across the planet seek to live up to high standards of digital preservation. Pendergrass et al. suggest that the key to "create[ing] sustainable digital preservation" lies in "re-evaluating what is required for successful digital preservation, and shifting to a model where management, successful use, and environmental sustainability are explicitly integrated into decision-making criteria" (Pendergrass et al. 2019, 181). While I particularly agree that environmental sustainability needs to be incorporated in decision-making processes, the how to accomplish this socio-cultural change requires further unpacking to not stop at mere symptom treatment.

This thesis argues that with recent attention to the subject of climate change, archival institutions pursue a strategy of mitigation and efficient energy use largely without addressing socio-cultural problems in the profession. Moving beyond symptom treatment towards diagnosing causes will ultimately require engaging with these issues. This responds to the

pressing need to pursue multiple strategies towards improving the environmental sustainability of digital preservation practice. For the scope of the research presented here, digital preservation is understood as a set of actions required to provide continuous access to a range of digital materials through time, and includes all actions taken to counter the threats of changing technological and social conditions (Digital Preservation Coalition 2015), with the addition of changing ecological conditions. More specifically, this thesis is concerned with digital preservation in the long-term, or the "continued access to digital materials, or at least to the information contained in them, indefinitely" (Digital Preservation Coalition 2015). Digital preservation relies on extensive use of information communication technologies (ICTs) (Pendergrass et al. 2019, 166). Recent work in sustainability and digital preservation offers a range of useful measures to mitigate negative environmental impact. To truly speak of an ecological paradigm in archives, however, this thesis challenges (1) the (almost singular) focus on increased efficiency to mitigate negative impact, (2) techno-optimism and the associated expectation that the future will provide answers, and (3) the lack of an endgame for digital presentation and its implications for finite resources. It is the aim of this thesis to examine the above, addressing the ecological frictions that emerge, and to answer the question of what criteria would constitute an archival ecological paradigm for digital preservation.

THEORETICAL FRAMEWORK

"Toward Environmentally Sustainable Digital Preservation" establishes the urgency of addressing the environmental impact of digital preservation by arguing that the success of (institutional) cultural heritage assumes "the social and physical constructions of a stable society" (Pendergrass et al. 2019, 166). A stability which will be increasingly disrupted by anthropogenic climate change. While they acknowledge the need for a paradigm shift towards environmental sustainability in archives, it is less clear how their own focus on energy efficiency and adjusting current practices to have less negative environmental impact contribute to such cultural change. Their research is based on the more general sustainability framework developed by industrial ecologist and environmental researcher John R Ehrenfeld, who criticises sustainable development approaches which primarily seek "some form of technology to improve efficiency" (Ehrenfeld 2008, 2). Ehrenfeld defines sustainability as "the possibility that human and other life will flourish on the Earth forever" while acknowledging that it remains a subjective and contested concept (Ehrenfeld 2008, 2). In more concrete terms, sustainability may be seen as a feature of systems which emerges from a combined consideration of "the economic, environmental, social, and cultural needs of both present and future generations" that values these stakeholders equally

(Lowe 2020). This would require "a deep shift in values", or moving away from current efficiency-oriented paradigms (Ehrenfeld and Hoffman 2013, Introduction). Despite the use of Ehrenfeld's framework, many of the measures proposed by Pendergrass et al. are centrally concerned with energy efficiency. While such measures do "reduce the impact of digital preservation practices" (Pendergrass et al. 2019, 167) they need to be accompanied by conscious cultural change, or what Ehrenfeld and Hoffman call "a fundamental shift in our way of thinking" (2013, Preface). Rather than primarily understanding sustainability as mitigation of negative impact, this thesis builds on Ehrenfeld's call for changing values to argue that an ecological paradigm shift in archives would need to challenge the interlinked assumptions of efficiency, technological solutionism and infinite progress. Importantly, this thesis does not set out to discourage the work done by Pendergrass et al., but points to what it perceives as a disconnect between their measures and the paradigm shifts which they – rightfully – claim are needed. I will elaborate on their approach in Chapter 1.

It is important to distinguish the more common use of sustainability used to signify the reliable longevity of funding and personnel within institutions from the use of environmental sustainability throughout the rest of this thesis. The former addresses "the whole socio-technical composition of the repository," but is concerned primarily with "building an economically viable infrastructure, both social and technical, for maintaining valuable data without significant loss or degradation" (Bradley 2007, 157). From an archival management perspective, archivist Heidi N Abbey defines sustainability as "meeting the social, environmental, economic, and cultural needs of the present without compromising the same needs of future generations," (Abbey 2012, 92). She further argues that archives have fallen behind their library and museum counterparts by not "taking a holistic approach and promoting simple, attainable, green initiatives that archivists can readily implement in their repositories" (Ibid.). With reference to the three central tenets of sustainability – social, environmental, and economic – she proposes that in order to function sustainably the archive's "success must be measured against not only income, but also against impact upon a community, or society at large, and the natural environment" (94). I compare this to Ehrenfeld's suggestion that sustainability means to accommodate the flourishing of all life now and in the future. Arguably, simple and ready-to-implement measures are part of a worthwhile approach to climate change, but on their own they do not address the underlying socio-cultural issues that contribute to unsustainable practice. In other words, digital preservation continues to compromise the flourishing of future generations. Ehrenfeld develops on this idea further with Andrew J. Hoffman, clarifying the idea that flourishing is about more than mere growth. Rather than a static quality, it is a dynamic concept which stands for a persistent change and the strive towards the well-being of all (Ehrenfeld and Hoffman 2013, Introduction). While the sustainable

development efforts up until now have brought many improvements, they consider these improvements "a Band-Aid that masks deeper, cultural roots" of the environmental challenges facing archives (Ehrenfeld and Hoffman 2013, Introduction). Sustainability, in this view, has been transformed into "a label for strategies actually driven by standard economic and institutional mechanisms around efficiency," which needs to instead (re)focus on the "behavioural, cultural and institutional underpinnings" of ecological crisis (Ehrenfeld and Hoffman 2013, Introduction). In support of this, sustainability as it is used in this thesis prioritises the environmental tenet and understands environmental sustainability also as a set of cultural values and not only as a characteristic applicable directly to technical systems or practices. An environmentally sustainable archival paradigm, then, requires cultural change in addition to the energy efficiency and similar improvements proposed elsewhere.

Techno-optimism, or assuming future technologies will solve present-day problems, which is expressed through efficiency-oriented approaches to environmental sustainability is also reflected in another important aspect of digital preservation's environmental impact, namely the question of planned obsolescence and the resulting e-waste problem. ICT components which are part of the technical infrastructure digital preservation relies on are disposed of regularly. Pendergrass et al. cited estimates of "approximately 45 million metric tons of electronic waste" produced yearly on a global scale in 2017, a staggering amount which was expected to continue to grow (Pendergrass et al. 2019, 175). In 2017, a fifth of the disposed components were responsibly recycled, and documentation was severely lacking for most of the remaining waste (175). The most recent Global E-waste Monitor indicates that 2019 saw a record 53.6 million metric tons, predicting numbers will reach 74 million by 2030, nearly doubling the quantity estimated in 2014 (E-Waste Monitor 2020). Significantly, "recycling activities are not keeping pace with the global growth of e-waste" (E-Waste Monitor 2020, 14). Both then and now, lower-income countries function as dumping grounds where raw materials are salvaged under life-threatening conditions by often underage locals (Pendergrass et al. 2019, 175). Digital preservation practice needs to continue working towards making maintenance and repair the golden standard instead of discard and replace (Russell and Vinsel 2016). Moving beyond techno-optimism involves consciously addressing the e-waste problem and the way (in)finite resources are spent.

In the conclusion to her book on e-waste, media sociologist Jennifer Gabrys presents what she calls "digital rubbish theory" (Gabrys 2011, 147). Based on the notion that the digital, though often thought of as an immaterial cloud, leaves substantial material traces and involves "an elaborate process of waste making," she argues that the study of e-waste should extend to the

forces that drive its production (v-vii). At work in environmental sustainability, she suggests, are two interrelated "waste fantasies", one of waste in abundance, and another of the complete eradication of waste (147). To Gabrys either vision is troublesome. The utopian imaginary of the zero-waste society, as expressed by work towards "the circular economy" (Bridgens et al. 2017, 169) and the more modest "carbon-constrained model" (Venkatraman 2011, 96) both lean into techno-optimism:

> In these scenarios, the assumption is often made that if markets emulate 'nature,' then it may be possible to arrive at perfectly streamlined material economies. In this way, economies may also become 'natural.' But the sense of the 'natural' at work here is twofold: it is supposed, on the one hand, that the 'natural' condition of environmental systems is to be at 'harmony' (i.e., nature produces no waste) and, on the other hand, that material economies will ideally emulate and advance such natural harmony through the eventual progress offered by new technologies and systems (Gabrys 2011, 149).

While contributing to improving the environmental impact of ICT-reliant practices, this commitment to technological progress as a cure-all for ecological challenges of the present, eludes responsibility and borrows unjustifiably from the potential for future generations to flourish. In *Dark Ecology*, where Morton argues for informed understanding and living with the realities of contemporary ways of life as the only way to responsibly move forward in the anthropocene (Morton 2016). For an ecological paradigm shift in archives, we need to avoid the temptation to assume that future solutions will help us 'restore' some notion of a nature that has been lost, and instead learn to responsibly live in contemporary ecologies.

METHOD

This thesis sets out to present an argument for the necessity of an ecological socio-cultural change, or paradigm shift, in archives. The development of this argument in the chapters that follow aims to make a first statement about why I believe this to be necessary, rather than claiming to hold all the answers. To do this, the thesis discusses the question of paradigm shifts (what do we mean by this?), problems with the current paradigm (efficiency, techno-optimism, and the lack of an endgame), and what criteria to encourage in a new ecological paradigm. The discussion, my position and proposed emerging criteria are developed based on a literature review and an engagement with the broader field of archival and media studies, and the manifesto of Extinction Rebellion, a contemporary environmental social movement. Finally, the thesis uses the NDSA

Levels of Digital Preservation model (Phillips et al. 2013) as a test case for evaluating those criteria.

The thesis builds on the supposed paradigm shift proposed by Pendergrass et al. to propose more explicit inclusion of socio-cultural change. The elements of a new archival paradigm borrow from the manifesto of Extinction Rebellion, a present-day movement which has done its fair share of provoking much societal discourse around anthropogenic climate change and (in)effective responses (Mansfield 2020; Seaton 2020; Malm 2021). I use their set of demands—Tell the Truth, Act Now, Let Citizens Decide, and Climate Justice for All (Extinction Rebellion Nederland n.d.)—as inspiration, along with alternative archival narratives to digital preservation, in developing the ecological values for which this thesis argues. The choice of the National Digital Stewardship Alliance (NDSA) Levels of Digital Preservation as a test case stems from its function as a set of guidelines for digital preservation practice (Phillips et al. 2013). Furthermore, the Levels of Digital Preservation are built on the logic of matching preservation activities with finite (economical, institutional) resources (Owens 2018, 79), which I argue may make it more suitable to build an ecological paradigm on.

As much of the discourse surrounding digital preservation and issues of environmental sustainability takes place on a variety of sources beyond peer-reviewed journals, this thesis also discusses material gathered from news sites, webpages and blogs, where appropriate.

SUMMARY OF THE THESIS

The layout of the thesis proceeds as follows. Chapter one sets out to examine the model proposed by Pendergrass et al. through the lens of literature on (archival) paradigms, to argue that the inclusion of more socio-cultural considerations is necessary before an ecological paradigm shift may take place. Particular attention is paid to their measures towards energy efficiency, to explain how their model contributes to techno-optimism. Additionally, some of the more innovative aspects of their model will be discussed to emphasise the potential implications for digital preservation of such a new ecological paradigm. Chapter two poses a thought experiment, namely what digital preservation may look like if it responded to present-day environmental movement Extinction Rebellion and their demands for honesty, immediate action, citizen participation and climate justice (Extinction Rebellion Nederland n.d.). This speculative experiment engages with alternative narratives to digital preservation; curated decay (DeSilvey 2017), slow archives (Rauch 2018; Christen and Anderson 2019), and urgent archives (Caswell 2021) extracting socio-cultural values which I argue would contribute to more ecologically responsible digital

preservation practice. Chapter three tests those values against the model of the NDSA Levels of Digital Preservation, envisioning what changes this ecological paradigm shift may promote in archival institutional practice. Together, these chapters lay theoretical foundations for future practical research and implementation, hoping to contribute to a more well-rounded conception of environmental sustainability in tomorrow's digital repositories.

Chapter 1 – Environmentally sustainable digital preservation: A paradigm shift?

The word 'sustainability' is increasingly receiving attention not only in the economic and staffing sense, but also environmentally. Recent attention is given to the fact that doing anything with data—storage, access or use—relies on ICT-technologies which represent a substantial contribution to energy consumption globally (Addis 2020). Two of the clearest advisory measures for tackling a cultural heritage institution's complicity in carbon emissions is switching to renewable energy sources and investing in more efficient energy usage (Pendergrass et al. 2019; PHI Factory 2021). Both of which are first steps towards mitigating the negative environmental impact of digital repositories. At the same time, there are complicating factors such as a market tendency to employ the word 'sustainability' in marketing. The Netherlands Authority for Consumers and Markets (ACM) recently announced they are conducting investigations regarding "many potentially misleading sustainability claims" in the energy sector (ACM 2021). Beyond difficulties in determining if investments in green energy are as green as their marketing suggests, there is a more fundamental obstacle for environmentally sustainable digital preservation: the dominant focus on increasing energy-efficiency through technical solutions (PHI Factory 2021). To truly speak of an ecological paradigm in archives, I will first turn to the term paradigm to unpack it before challenging the dominance of energy efficiency, technical solutionism and progress-oriented thinking in discussions surrounding environmental sustainability and digital preservation.

This chapter does not argue that energy efficiency is counter to sustainability, but rather than it only goes so far towards building sustainable practice which promotes "the possibility that human and other life will flourish on the Earth forever" (Ehrenfeld 2008, 2). There is a substantial difference between working towards the mitigation of negative impact, and building sustainable digital preservation practice. What is needed here is a hybrid approach where on one end measures are taken to identify and mitigate emissions and unsustainable practices, and on the other end we consider ways of changing cultures of consumption. One way to consider this, which will be further developed upon later in this chapter, is through the lens of Jevons' Paradox. Jevons' Paradox is "an ecological economics concept that explains how greater efficiency of a process leads to increased use of the resources in that process" (Pendergrass et al. 2019, 172). This concept goes some way towards explaining how "[n]ew technological efficiencies in record-making practice can increase the amount of material that an organization preserves, leading to a greater net environmental impact through increased use of physical storage" (Pendergrass et al. 2019, 172). In other words, more energy efficient digital technologies for storage and access do not necessarily make digital repositories more environmentally sustainable. An ecological archival

paradigm would need to address the escalating amount of information created which may be relevant for digital preservation efforts (IDC Media Center 2021).

This chapter sets out to unpack the term paradigm shift and what criteria can be considered relevant for a new ecological paradigm in archival studies. Using the model proposed by Pendergrass et al. to highlight the limitations of a mitigation-focused approach. The authors rightfully argue that "[u]sing technology to reduce digital preservation's environmental impact … will not result in environmentally sustainable digital preservation," (180) and instead "[c]all for a paradigm shift in digital preservation practice in the areas of appraisal, permanence and availability" which they follow up with "a model for sustainable practice" (165). Their efforts to generate a cultural re-thinking of approaches to digital content are all well and good, but because they still mainly suggest mitigatory adjustments to current practice, the result may simply "validate that decisions made out of financial or staffing necessity are the environmentally responsible choices" (167). Returning to Ehrenfeld's arguments, they repeatedly acknowledge that "society needs a paradigm shift away from satisfaction through consumption" in order "to create sustainability," yet mainly deliver "compromises" with "current digital preservation practice" which follows the logic of consumption (180). This approach, while contributing to efforts to reduce negative environmental impact, thus, fall short of engaging with the techno-optimism that often accompanies digital preservation as a societal project. I will return to this later in this chapter, but I need to begin with a closer look at the term paradigm and its use within archival studies.

(R)EVOLVING PARADIGMS OR ARCHIVAL MINDSETS

> A very demanding condition … is that scientific revolutions bring forth ideas which are not merely new, but were unthinkable before. (Solleveld 2015, 232)

In his seminal work, *The Structure of Scientific Revolutions*, Thomas Kuhn made major contributions to the history of science by studying the work of scientists (1970, originally published 1962). The most long-lived contribution is Kuhn's conception of paradigms, or "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" (1970, viii). A key element here is the notion that paradigms only stand if they are useful for providing questions and solutions to observed practice. Throughout periods of normal science, exceptions and contradictions emerge which eventually

contribute to the failure of a paradigm to produce solutions (Kuhn 1970, ix). These crises leave openings for the emergence of new frameworks which better address the problems faced by a particular community. To Kuhn, such a paradigm shift "alters the historical perspective of the community that experiences it" (Kuhn 1970, ix). As a sociology of science, it is important to highlight how Kuhn's focus was on the cultural values of specific communities. For example, a community of archivists undergoing a paradigm shift would experience a cultural change in the values they held and how they view the work they previously did. Additionally, one difficulty in announcing or promoting a paradigm shift is the concept's roots in a historical perspective. It is not entirely simple to observe cultural change while it is happening. What is clear about Kuhn's use of the term paradigm shift, however, is that it has substantial cultural components.[2]

One of Kuhn's most significant criteria for a paradigm shift occurring is incommensurability. The gap between two paradigms is their "incommensurable ways of seeing the world and of practicing science" (Kuhn 1970, 4). A new paradigm necessarily is preceded by a series of inquiries that successively build towards "a new set of commitments" (Kuhn 1970, 6). In other words, a new ecological paradigm in archival studies would have to work according to a different set of standards than a previous paradigm. Kuhn's examples are distant in time and different in field from digital preservation—Copernicus, Newton, Lavoisier, Einstein—but his core conceptual criteria for paradigm shifts remain relevant:

> Each of them necessitated the *community's rejection* of one time-honoured scientific theory in favour of another *incompatible* with it. Each produced a consequent shift in the problems available for scientific scrutiny and in the standards by which the profession determined what should count as an admissible problem or as a *legitimate problem-solution*. … Such changes, together with the *controversies* that almost always accompany them, are the defining characteristics of scientific revolutions. (Kuhn 1970, 6, emphasis in original)

Kuhn further specifies that while the term paradigm shift implies a certain pivot point, these shifts emerge over a period of time and dispersed across a community of practice—not generally from individual work or points in time (1970, 7)—and is not necessarily significantly felt outside of that community (180-1).

[2] In their work on recordkeeping informatics, Frank Upward and his colleagues establish information cultures as one of their primary facets of analysis, recognising how the work of archivists continues to be significantly embedded in and informed by cultural values and attitudes (Upward et al. 2018).

Several scholars have offered reflections on the concept's wider use in the Humanities. Michiel Leezenberg suggests that paradigms represented a move towards "pragmatism" or a focus on actual and desired practice (Leezenberg 2018, 379). He emphasizes that Kuhn's later work turns away from "'great' revolutions" and towards "less radical or global changes" (Leezenberg 2018, 118). This shift contributes to the more general (ab)use of paradigm as a concept (Leezenberg 2018, 119). While Kuhn hesitated to use paradigm to discuss developments beyond he natural sciences, there have been similar discontinuity in the progress of knowledge in the Humanities (Leezenberg 2018, 133). Kuhn was of the persuasion that while some "read its main theses as applicable to many other fields," there are significant differences schools and the centrality of "puzzle-solving as a goal" in the former as examples (Kuhn 1970, 208-209). In his work on the history of the humanities, Rens Bod questions this line of division, setting out to examine the Humanities for "*progress in the degree to which the particular problem could be solved*" (Bod 2013, 244, emphasis in original). His most relevant result for this discussion suggests that "the idea of progress and the associated notion of scientific growth are applicable to the humanities" (Bod 2013, 249). Floris Solleveld, however, questions whether the same criteria can be used to describe the Humanities or if a different set of terms are required: he proposes we may rather speak of "conceptual change" than paradigm shifts, where the use of a concept in the Humanities changes between contexts (Solleveld 2015, 224). He criticizes the use of paradigm shift in the humanities as "a *mystification* rather than an explanation" (224, emphasis in original). The main issue, in his view, stems from the criteria of incommensurability, which he suggests is at odds with the way work is done in the Humanities: "in a field of research without clearly defined units and denominators, no experimental evidence, and far less intricate model-construction, the notion of 'incommensurability' can only apply in a derived sense" (Solleveld 2015, 231). In other words, as previous findings are not made irrelevant by new understandings, there is room for multiple readings in the Humanities.

This brings me to how the term has primarily been adopted within archival studies. Terry Cook famously proposed that there have been four phases of archival paradigms:

> From juridical legacy to cultural memory to societal engagement to community archiving. The archivist has been transformed, accordingly, from passive curator to active appraiser to societal mediator to community facilitator. The focus of archival thinking has moved from evidence to memory to identity and community, as the broader intellectual currents have changed from pre-modern to modern to postmodern to contemporary" (Cook 2013, 117)

Evidence, memory, identity, and community, then. Four archival paradigms. It may seem like a simple next step to suggest an ecological archival paradigm, but Cook's use of the terms is quite specific. To Cook, the formal meaning of paradigm may be too rigid for his argument, proposing that instead of using Kuhn's term, these four phases may be "better styled as *frameworks* for thinking about archives, or archival *mindsets*, ways of imagining archives and archiving" (Cook 2013, 97). The strength of such mindsets, Cook argues, is that they can authorize "new directions in light of the astonishing challenges to archiving today from theory, technology, and society, and the expectations and demands each occasions." (Cook 2013, 117-8) In my view, another strength lies in that it puts minds and culture at the centre of the discussion, while paradigms appear as externally held abstractions of communal practice. To take on the challenge posed to archives by anthropogenic climate change, a new ecological mindset might therefore be empowering. The chief difficulty lies in fostering such a paradigmatic shift which also acknowledges "evident differences, often fundamental, about the core values of the archival endeavour" (Cook 2013, 99). The good news is that this conceptualization allows more flexibility in terms of the criteria of incommensurability. In fact, Cook emphasises that "these four accumulate across time; they do not entirely replace each other" (Cook 2013, 105). This diversion from Kuhn and others makes the emergence of a new ecological paradigm, or mindset, a less severe break with previous practice—for better or worse.

Finally, before moving on, I would like to linger a moment on the idea of archival turns and returns (Ketelaar 2017). Eric Ketelaar suggested that various "'turns' in other disciplines may have an intrinsic or material effect on the ontology of the archive(s), inevitably leading to the *adoption of concepts*" (Ketelaar 2017, 229, emphasis in original). Various disciplines are in the process of responding to the changing ecological conditions of climate change brought on by human activity. As they develop concepts that prove fruitful in their own contexts, these concepts may receive attention and use beyond disciplinary borders, evolving as they travel into new contexts (Bal 2002). Perhaps what can be observed in archival theory is more of an ecological turn—with the profession finding ways to implement findings from industrial ecology and similar fields. Whether we consider the recent attention to the climate change question a paradigm shift, conceptual change, a new mindset, or an ecological turn, each conceptualization requires a more hybrid approach where the need for changing cultural values in the profession receives more critical attention. Having some idea of the various ways one can think about such cultural change in digital preservation, I will now move to contemplate how one might best position the model proposed by Pendergrass et al. and how to move further towards environmentally sustainable practice.

ON MITIGATION, ADDITIONALITY AND SUSTAINABLE PRACTICE

The results presented by Pendergrass and their colleagues does a lot of good towards improving the environmental sustainability of digital preservation practice. Within their focus areas of appraisal, permanence, and availability, they produce a set of critical questions for digital preservation professionals to ask themselves throughout their work. Several of these questions challenge dominant ideas of how much material is to be kept, the intensity of efforts towards maintaining fixity, and the demand for constant and direct access for all materials (Pendergrass et al. 2019, 185, 191, 195). Perhaps their most significant contribution lies in their comprehensive review of the environmental costs of digital preservation and the technical infrastructure and components on which the work relies. But their wider cultural ambitions are clear: "It is time for all cultural heritage professionals who work with digital content to engage with this urgent issue and to critically evaluate current practices in appraisal, permanence, and availability of digital content to create environmentally sustainable digital preservation" (Pendergrass et al. 2019, 196). While there are elements of their report that directly address the need to reconsider choices that are made throughout the work of digital preservation, one of the main takeaways from reading their article is a focus on mitigating a negative environmental impact through means of technical developments in energy and storage efficiency. One example of the work inspired by their findings is a recent report on behalf of the Dutch National Archives and Royal Library titled "The CO2-impact of storage and use of digital heritage: With Delpher as case study,"[3] which picks up on the question of carbon footprint and how this footprint can be minimized on the basis of product life cycle analyses and green energy (PHI Factory 2021). Starting with mapping out the environmental impact of storage and access is well-aligned with Pendergrass et al.'s model, but there is a noticeable concentration of efforts into mitigating institutional carbon footprint through effectivization: "What is the ecological footprint and how can it be made as small as possible"[4] (PHI Factory 2021, 3)? In their final recommendations they hint at cultural components which lie outside the scope of the report:

> One factor that was not included in this case study, is the impact of a stricter selection and preservation of digital heritage on total CO2-emissions of a heritage institution. … Naturally heritage organisations want to be as complete as possible in the materials they offer to their users. However, by possibly limiting the digital collection, logically CO2-emissions can be avoided in a variety of ways.[5] (PHI Factory 2021, 22)

[3] Translated to English from Dutch original.
[4] Translated to English from Dutch original.
[5] Translated to English from Dutch original.

I would argue that the mapping of CO2-impact done by this report is a solid first step towards understanding and working on the environmental sustainability of digital preservation practice, it is clear that it leaves some difficult cultural questions undiscussed. The issues of what to keep, in which state, and for how long in Pendergrass et al.'s model.

In terms of clean energy, Pendergrass et al. argue that "mak[ing] use of clean electricity sources" is a key move towards sustainability. Not only does it allow for a reduction in unsustainability, but performed right it might also positively promote the growth of sustainable practices. Cultural heritage institutions should verify that purchased energy is sourced from the "regional electricity grid (…) and that the utility does not count them to meet its compliance mandates" (180). This practice would contribute to sustainability in the form of "additionality," or "ensur[ing] that new renewable resources will be added to the regional grid and will help to displace non-renewable powered resources" (180). It is important to consider that the context of the relevant national or regional energy market is crucial for understanding how this additionality can be promoted. While Pendergrass et al. base their analysis of the US-context, the PHI Factory report considers how green energy functions on the Dutch energy market. According to their analysis, all electricity producers deliver onto the same electricity grid, and all consumers receive their electricity from this grid, without the possibility to directly link a cultural heritage institutions energy use to renewable energy sources. Instead the system relies on the institution paying for "Guarantees of Origin" which allocates a quantity of green electricity produced to the purchaser (PHI Factory 2021, 11). In this context, reducing the total institutional use of (renewable) energy leaves more green electricity for other consumers: lessening the need to dip into grey, or non-renewable, energy supplies. In this way, additionality likely represents a powerful push towards sustainability. However, it is noteworthy that Pendergrass et al.'s themes contribute to the same narrow focus on electricity use of digital preservation efforts that the authors criticise in their literature review. While Pendergrass et al. position these technological measures as contrasts to their own cultural paradigm shifts, their own approach in a similar fashion primarily engages in treating the symptoms.

At play here is a tension between on the one hand mitigatory efforts, which can be said to represent a negative sustainability logic, and on the other hand efforts to enact sustainable practice, or a positive sustainability logic. In other words, sustainability by absence of negative impact, versus (potentially major) cultural shifts in practice. This positive logic of sustainability comes to the fore primarily in what Pendergrass et al. call "environmentally sustainable digital practice" (2019, 168) which covers the larger question of "how digital content management and preservation impacts the environment" (172). One significant element of their argument is

promoting consideration of environmental impacts before developing or acquiring new devices, systems and other digital resources, with particular attention paid to "proper end-of-life recycling, the impact of digital versus analog, and the production chain and labor practices involved in making the product" (Pendergrass et al. 2019, 172). This reflects the growing awareness that current practice requires rethinking of the scope of digital preservation:

> [I]n light of an eventual post petroleum future coupled with more impactful near-term ecological changes, libraries will be unable to maintain their current collecting priorities and digital content. (Pendergrass et al. 2019, 172)

While the above conclusion is directed specifically at libraries, the threats on the environmental horizon similarly challenge the digital preservation activities of other cultural heritage organisations. Calls for "an interdisciplinary approach" to engage with the "energy- and carbon-intensity of digital preservation practices" are becoming more common (Pendergrass et al. 2019, 172-3). Citing Linda Tadic's presentation at the Association of Moving Image Archivists (AMIA) 2015 Annual Conference, they note "the importance of responsibly recycling and reusing the physical media itself and that large-scale digitization of magnetic media in CHOs will exert massive stress on digital preservation infrastructure" (2019, 173). Another significant challenge to the business-as-usual of digital preservation comes from Ben Goldman who criticizes the "focus on authenticity of digital content and trustworthiness of digital repositories" which has resulted in a significantly more "resource-intensive digital preservation" than might be possible if those approaches would instead "embrace acceptable levels of mutability" (Pendergrass et al. 2019, 173; Goldman 2019). Despite the rise in awareness, Pendergrass et al. note, discussions of environmentally sustainable digital preservation continue to revolve primarily around "the electricity use of technological infrastructure" (Pendergrass et al. 2019, 173). Instead, the archival profession must move towards a multiple or hybrid approach to better address not only the perpetually "increasing scale of digital content," (Pendergrass et al. 2019, 166) but also the broadening of categories of content relevant for digital preservation: "born-digital and digitized text, image, and audiovisual content; research data; personal digital archives; digital records; and web and social media archiving" (Pendergrass et al. 2019, 196-7). Despite the often-inspiring leaps in technological development in areas such as storage, processing and server technologies, (environmental, financial, and social) resources have always been and remain finite.

THE TEMPTATIONS OF TECHNO-OPTIMISM

I return here to the question of shifting paradigms and how this may apply to the current state of digital preservation. The efforts by Pendergrass et al. to promote a new way of thinking about preservation actions notwithstanding, the implementation so far show stronger signs of "try[ing] to elaborate and to refine" current theories than to refute them (Leezenberg 2018, 119). The question is whether the archival adaptations asked by climate change will produce severe enough anomalies, or unsolved problems, that enough digital preservation professionals develop a sense of crisis—"a widespread and uncomfortable feeling that something is serious wrong with the existing paradigm" (Leezenberg 2018, 120). The Kuhnian perspective holds that such crises may allow for an ecological (r)evolution of archival theory and a disruption of the utopian dream to save everything: "Scientific revolutions … involve not linear growth or accumulation of knowledge but *destruction*: much of what had been seen as solid scientific knowledge is now rejected or brushed aside as false, nonsensical, or even incomprehensible" (Leezenberg 2018, 120). Though there are voices beginning to discuss the topic of climate change adaptation in archives, there is some way to go to think of a widespread discomfort in the profession. It may be more productive to build on Cook's notion of a paradigm as a mindset: instead of rejecting prior knowledge accumulation outright, it is more appropriate to think of a hybrid approach. A hybrid approach where on one hand direct measures can be taken towards mitigation, while on the other hand efforts are made to make room for more digital preservation professionals to feel that same discomfort. In what follows, I will discuss techno-optimism, followed by the lack of an endgame for digital preservation to hopefully confront digital preservationists with two of the lingering tensions between their work and the idea of environmental sustainability. Such questioning of deeply rooted cultural values, I argue, is necessary to make possible the kind of change of mindset which in Kuhnian terms may be considered "a gestalt switch" (Kuhn 1970, 204).

Techno-optimism, as I have come to call it here, has been called different things in different contexts, but essentially comes down to a dominantly positive attitude to new and sleek technical solutions and applications, often with too little question of whether these solutions actually address the problems for which we seek solutions. In his book, *To save everything, click here*, Evgeny Morozov calls one aspect of this attitude "technological solutionism" (2013). In his view, solutionism as "ideology" functions by "[r]ecasting all complex social situations either as neatly defined problems with definite, computable solutions or as transparent and self-evident processes that can be easily optimized" (Morozov 2013, 5). It comes coupled with "an unhealthy preoccupation with sexy, monumental, and narrow-minded solutions" (Morozov 2013, 6). While Morozov's tone is purposefully provocative, I argue there to be a valuable corrective imperative

in his words. Digital preservationists need to take to heart “the inapplicability of ‘technological fixes’ to ‘wicked problems’” (Morozov 2013, 6). I want to make it clear, again, that this is not to suggest that technology shouldn’t form part of the solution, but that “[i]n promising almost immediate and much cheaper results” techno-optimism may outcompete “other, more fruitful, more humanistic, and more responsible ways to think about technology’s role in enabling human flourishing” (Morozov 2013, 9, 14). As Trevor Owens suggests in his book on digital preservation as vocation, “[d]igital preservation is not primarily technical in nature” (Owens 2018, 73). In other words, the reality of budgeting means multiple approaches compete for limited institutional resources. The danger here is overtly technical solutions encourages delaying or neglecting work on changing cultures (of sustainability), a work which is notoriously slow and requires long-term dedication of resources.

A possible factor which contributes to techno-optimism is the hyperbolic discourse that surrounds new technologies: "It is as if digital information will last forever but also, somehow, disappear dramatically all at once. The hype cycles of digital technology, combined with a basic lack of understanding about digital media, leave us ill-equipped to sort through the hype and anxiety" (Owens 2018, 1-2). These tendencies towards hype and anxiety feed into what Owens labels “technological utopianism” (Owens 2018, 194). Echoing Morozov’s reservations surrounding technological solutionism, Owens points to so-called “moon-shots” or “singular technical solutions to the problem of enduring access to digital information” (Owens 2018, 1). He suggests that such “techno-fantasy-illusion” represents “a distraction not worth chasing” (Owens 2018, 192, 2). Especially note-worthy in such a resource-constrained context is the possibility that, contrary to common beliefs, the cost of storage may come to increase drastically going forward (Owens 2018, 190). When seeing the steady stream of technical innovations and new systems, the pace of change might make it feel as if a solution to climate change adaptation, or the problem(s) of environmental sustainability, lies just around the corner of another tech investment. Not only is this a threat to the idea of successful adaptation, but more broadly to the project of digital preservation:

> One of the biggest threats to the sustainability of digital information now and into the future is the defunding and underfunding of our cultural and civic institutions. To this end, one of the biggest things we can do to support digital preservation is to demonstrate the value and relevance of our work to the communities we serve. (Owens 2018, 194)

While demonstrating how digital preservation work aims to remain valuable and relevant to other communities will be returned to in chapter 2, for now one notion emerges: without incorporating efforts to balance out techno-optimism with a more ecological archival mindset, such narrow

resource allocation is unlikely to truly address the associated cultural issues. Rather than abstractions, the future holds very real challenges for archives: "[m]any cultural heritage institutions may be literally under water in the next century" (Tansey 2015; Owens 2018, 197).

Already in 2008, Dan Chudnov spoke about "fetishizing software products or projects" in relation to digital repositories as something to be avoided (Chudnov 2008, 39). Though his reflections took place in a different context than anthropogenic climate change, he too recognized that digital preservation work goes beyond the technical: "[e]very software repository I've helped to build has faced complex issues of planning and policy which had little to do with technology and everything to do with how to build a sustainable program for ensuring access over time" (Chudnov 2008, 41). Another potential contributing factor to techno-optimism is what Devon Mordell has referred to as "a growing preoccupation in archival literature with characterizing digital archives as *big data*" (Mordell 2019, 140, emphasis in original). Rather than an ecological paradigm, he proposes that what we may be observing is better labelled "an archives-as-data paradigm" (Mordell 2019, 140). His fear is for a (re)turn to past ideas of the neutrality of archives (Mordell 2019, 140)—the notion has been brought up before in critical media studies which proposes that data do not simply exist in some untreated state but undergo a process of datafication (Gitelman and Jackson 2013; Mordell 2019, 144). I argue that rather than a new paradigm, this is an extension of the evidence mindset mentioned earlier in this chapter: "ironically, as archivists were more confidently finding their own voice as societal agents, … they were also developing more sophisticated means by which archives were managed, and evidence protected" (Cook 2013, 111). The idea that prior archival mindsets don't dissipate once a new one emerges, but rather exist in parallel, would suggest that this data-paradigm may be more of a resurgence for a framework that has remained dominant even as memory work and community archives became more prominent. The influence of such data perspectives, however, feeds into techno-optimism—where progress is measured by ever-more data available to the new dominant user—the data scientist.

(THE DREAM OF) INFINITE PRESERVATION

Engaged in this strive to collect, preserve and provide access to ever-increasing holdings of data the creative efforts of archivists are dominated by finding new ways of working at-scale to keep up with this growth. A series of technical solutions to problems that are not only technical in nature, without an end in sight. This brings me to what I argue is the central cause of friction between digital preservation and environmental sustainability: the lack of vision for a preservation endgame. While Verne Harris has discussed how archivists as human beings "are all caught up in

the dynamics of endgame" (Harris 2011, 122-3) there has been little discussion in digital preservation circles about how to cut down the scope of their vocational efforts. In fact, the current understanding of the craft suggests an eternally growing project:

> There is no end for digital preservation. The best one can hope for is to be one link in an unbroken chain of memory. Given the challenges our world faces, I think those links to our past, those connections to facts, and the decisions we make about whose stories matter enough to constitute our collective social memory are now more important than ever. I hope this book can serve in some small way as a useful guide to those who want to help maintain and repair that chain. (Owens 2018, 200)

On one hand, the idea that preservation work is part of maintaining and repairing an unbroken chain has valiant qualities and is based on long traditions of knowledge preservation and the delivery of this knowledge into the future. But digital preservationists need to exhibit caution in buying into this image of a guardian through time, if nothing else because the amount of material being created and needing to be brought into this chain is becoming untenable (Rosenthal 2012b; IDC Media Center 2021).

The idea of progress without limit has long been supported by two related maxims, Moore's Law and Kryder's Law. While not laws in the formal sense, these ideas have been instrumental in encouraging a view of technological progress as exponential and with virtually no end point. But the reality is that however ephemeral new technologies and the language that surrounds them get, they are based in a material and physical reality which is a lot more finite than technology innovators suggest. Moore's Law has come to propose that the number of transistors on a chip double every two years, a tenet of technological development which at the very least guided technological development of processing power for decades (Rotman 2020). Not only has there been a "gradual decline" in this progress rate, but the production of new generations of chips is proving "prohibitively pricey" (Rotman 2020). Kryder's Law is a more recent observation in the area of drive storage by Mark Kryder which postulates that "the density of information on hard drives 'increases by a factor of 1000 every 10.5 years'" or a doubling rate of 13 months (Walter 2005; Network Computing 2008). Also known as the Kryder Rate, this pattern has informed "the idea that every few years we should be able to buy significantly larger volumes of digital storage for lower and lower prices" (Owens 2018, 190). I certainly recognise the feeling of upgrading to larger storage media, and subsequently still running out of space. Not only do our consumption habits quickly adjust to make use of any new storage space developed, but there are also worrying signs that the Kryder Rate is slowing down:

> For a number of years this rate of change has stalled out. The core take-away from this shift is that 'storage will be a lot less free than it used to be.' Importantly, the pace of growth for the creation of digital content has not begun to slow down. The result is that in the future the costs of storage are likely going to take up more and more of the resources and budgets of institutions engaging in digital preservation activities. (Owens 2018, 190)

Some would suggest that prices dropping at a much slower rate while production/consumption of information and processing continues to grow may cause substantial disruption even before we reach the physical limits of processing and storage. Rosenthal observes that "[p]aper survives benign neglect very well, but bits are very vulnerable to interruptions in the money supply. No-one has enough money to preserve even a fraction of the content worthy of preservation" (2012b). He further argues that while "[i]t is always tempting to think that exponential curves will continue" the passing of time tends to reveal that they are "the steep part of an S-curve" (Rosenthal 2012b). The potential disruption point comes from three parallel developments: rising demand, slowing of increases in capacity, and stagnant IT-budgets (Rosenthal 2012b).

The current trajectory of this (dream of) infinite preservation takes archives, records, and users, into the cloud. Much archival material has made the move from shelves to in-house servers, to internal or external data centres with "cloud and other networked storage systems," with the unfortunate side-effect that "digital storage is increasingly disassociated with its physical impacts" (Pendergrass et al. 2019, 173-4). Archives and other cultural heritage institutions are necessarily implicated in this process of disassociation, and lack of object permanence, when they co-produce the narrative of techno-optimism. The core tension stems from a culture of immateriality among archive workers and end-users to encourage a culture of unrestrained and expanded use of limited resources while progress is increasingly disrupted by the very real limitations of those resources. Adding to these issues, the variety of materials considered for long-term digital preservation is expanding to include not only digitized paper records and heritage, but also "born-digital and digitized audiovisual materials, research data, personal digital archives, websites and social media, and digital records" (175). These developments become even more troubling "when considered in aggregate" (176). Pendergrass et al. base their discussion on the *Beyond the Repository* survey conducted by the Online Computer Library Center (OCLC) using "a conservative estimate of approximately 5,750 petabytes" being preserved by cultural heritage institutions (176). Accounting for the risk-averse practice of keeping multiple redundant copies to prevent loss, these numbers and their energy and storage space requirements scale three or more times (176). The survey identifies "a high growth rate of preserved content, with many respondents expecting the content that their organizations preserve to double or more in the next

year" (176). Thus, the urgency of challenging techno-optimism and progress without an idea of endgame in digital preservation.

TOWARDS A PARADIGM SHIFT: WHERE TO GO FROM HERE?

This thesis has set out to think about whether environmentally sustainable digital preservation is even possible and, if so, what cultural values are damaging or helpful to a new ecological mindset among archivists. What I have done here is a first statement (based on literature review) about why I think this is necessary with a focus on what I hold to be unsustainable cultural values. Moving forward I will develop on what I argue are helpful values based around a thought experiment where I respond to the demands of the Extinction Rebellion manifesto: 0 – climate justice, 1 – tell the truth, 2 – act now, 3 – let citizens decide (Extinction Rebellion Nederland 2021) using the literature of various communities and some prominent counter-narratives to sustainable development and digital preservation thinking. This is not at its core a project to reject digital preservation, but to explore how lessons can be learned about how digital preservation can be done better in service of the flourishing of future generations. In defense of social responsibility and the need to address alternative narratives, I turn to the suggestion by Randall C. Jimerson:

> Changes have already come, and more are on the way. If archivists do not engage these discourses and movements, we will lose yet another opportunity to make positive contributions to society. (Jimerson 2010, 690)

At the core of this thesis lies the imperative that in order to not squander such opportunities the profession needs to bring the work of transforming cultural values and the work they inform back into the attempts to imagine and implement environmentally sustainable digital preservation.

Chapter 2 – The value of listening to alternative narratives

> Liberatory work is complicated. … It is discomforting for those of us who inhabit oppressor positions. It should be. (Caswell 2021, 107)

In my previous work with institutions and communities, one of my main takeaways was the necessity when coming into complex situations is listening to other perspectives. Whether these perspectives end up being (partially or fully) addressed in my own work they have always added valuable lessons and a sense of humility that crosses borders. The following chapter departs from the above and Caswell's suggestion that discomfort is part of partial of questioning structures which have long contributed to various forms of inequity. It also takes inspiration from Caswell's sometimes speculative style, which seeks to bring "empirical and theoretical work" together with efforts to imagine (liberatory) alternatives (Caswell 2021, 12). She develops on this further, explaining that:

> By imagining what does not yet exist, but might if we collectively will it, I am trying to extricate archival theory and practice from the constraints of the oppressive systems in which it is rooted and for which it has been a tool. My speculation is normative and prescriptive in the sense that I identify directions that I think archival theory and practice should take at the same time acknowledging my opinions about the future of archival practice are that of one person among many." (Caswell 2021, 12)

This is approach responds to the difficulties of developing new mindsets, it is a partially creative endeavour. Thus, as discussed in my introduction, I propose a thought experiment of what new viewpoints may emerge if we take the demands of environmental activist movement Extinction Rebellion as imperatives for archival theory and practice. Jennifer Rauch, in her book on the (emergence of a) slow media movement propose that "[w]e find inspiration in manifestos like these that confirm we are not alone in seeking change" (Rauch 2018, xxiii). Essentially, what this chapter sets out to do is enact a dialogue between these demands and alternative narratives of (digital) preservation. The hope is that such cross-pollination will inspire new ways of thinking as part of an ecological archival mindset.

Another reason to seek outside perspectives lies in the notion of (super) wicked problems. Timothy Morton, speaking about climate change, has suggested that wicked problems are ones with "uncertain boundaries because they are always symptoms of other problems," and dependent

on the framing of the issue (Morton 2016, 36-38). Listening to the perspectives of others on such problems help us better understand the "problem of which these things are symptoms" (Morton 2016, 38). Furthermore, the difficulty lies in the idea that there is no plan(et) B—"there are no trial runs, no reverse gears, no attempts to solve wicked problems, only actual solutions that drastically alter things" and we lack the ability to determine if and when "we have solved it" (Morton 2016, 36-7). Actively paying attention to potential counter-narratives to digital preservation will help ensure that the work of ensuring the persistence of digital information is the best that it can be, if only for the present moment.

Extinction Rebellion (from here on, XR), as many global social movements, represents many things to a variety of people. Their visibility in media coverage has brought much needed attention to the urgency of the question of how to tackle what they call a climate and ecological emergency—Fiona Mansfield summarizes the extent of this influence:

> [XR has] appeared repeatedly in the headlines globally, with branches in 72 countries. Their strategy uses mass civil disobedience and non-violent direct action to demand climate action, attracting both criticism and support from all angles. Extinction Rebellion's approach may be imperfect, but it has shifted the conversation around climate change and has succeeded where traditional means of protest failed. The movement has injected urgency and hope back into the issue and contributed to the declaration of a climate emergency in cities around the world. (Mansfield 2020, 375)

Emerging in the UK in October 2018, initiated by a small group of activists, academics and professionals, XR announced their "rebellion" against, in their view, stagnant or non-existing action on behalf of government and corporations (Mansfield 2020, 377). Their chosen strategy, seeking to enact mass instances of civil disobedience and subsequent arrests to force a dilemma of governance, "has repeatedly faced criticism" because of lacking recognition of how minoritized communities are disproportionately targeted by law enforcement in such situations (Mansfield 2020, 377). This has been part of a process of revision within the movement, developing upon their demands to better resonate with wider calls for (climate and racial) justice. Because the demands are adapted to local contexts, and informed by the consent of decentralized local groups, they vary from place to place.

In the discussion below, I have chosen to take the Dutch branch's formulation of the demands as the starting point because of their consistently ongoing work on better addressing the

question of a just and equitable transition into the future. Currently, the demands are formulated as follows:

> 0. "**Climate justice for all**: we demand a just transition that centres the needs and voices of those on the environmental frontline and holds to account those most responsible for ecological breakdown."
>
> 1. "**Tell the truth** about the climate crisis and the ecological emergency that are threatening our survival;"
>
> 2. "**Act now** and do what is necessary to stop the loss of biodiversity and to reduce greenhouse gas emissions to net zero by 2025;"
>
> 3. "**Let citizens decide** on a fair and equitable transition by establishing a citizens' assembly that will play a leading role in decision-making;" (Extinction Rebellion Nederland n.d., emphasis added).

These demands recognise that the climate crisis impacts peoples to variable degrees, often with those countries least responsible for (and prospering the least from) emissions and unsustainable practice facing the most severe instances of climate change (Extinction Rebellion Nederland n.d.). They see raising awareness only as a first step towards recognition of the scale of the emergency, moving towards "concrete measures" in adapting to climate change—prioritizing the existential threat it represents (Extinction Rebellion Nederland n.d.). Arguably most importantly, the demands address the often slowing "influence of powerful corporate lobbying efforts and politicians' dependency on favourable media coverage" in mitigating or adapting to climate change, sharing "the burden of resolving the crisis" between many societal actors—particularly involving individuals in the decision-making process (Extinction Rebellion Nederland n.d.).

DEMAND 0: CLIMATE JUSTICE FOR ALL

Picking up on the notion of inequity, there has been an increasing recognition of how the drive towards continual technological development, innovation and progress (most often associated with European or North American nations) upholds a system characterised by inequality and injustice. Trevor Owens observes that:

> The revolving cast of ever sleeker new computing gadgets in the privileged minority world is predicated on deeply problematic labor conditions in the majority world, the exploitation of natural resources, and environmentally and socially problematic factories.

> Beyond that, it's not just the problems of producing computing technologies but also the problems of where they end up when they have been quickly discarded. (Owens 2018, 197)

While different in scale to the activities of information giants like Google or Amazon, this also implicates digital preservation processes. But how can we think about archives and their role in accommodating climate justice? One direction being explored in the profession is the possibilities of minimal computing, the basic idea of which is expressed in Dan Chudnov's "The Emperor's New Repository," where he argues for how "the content that lasts online the longest is almost always the content with the least amount of stuff around it that can go wrong" (Chudnov 2008). Current developments here are driven by the ambition of digital humanities projects to foster collaboration across regions without privileging researchers and institutions with heavy computational capacity (Global Outlook::Digital Humanities n.d.). Thus, GO::DH labels itself a "critical movement, akin to environmentalism, asking for balance between gains and costs in related areas that include social justice issues and de-manufacturing and reuse, not to mention re-thinking high-income assumptions about 'e-waste' and what people do with it" (Global Outlook::Digital Humanities n.d.).

Minimal computing goes hand-in-hand with another branch of thinking around technologies and sustainability—namely those scholars and practitioners redirecting towards the long traditions of repair and maintenance. What Steven Jackson calls broken world thinking shifts interest and appreciation from "innovation, development, or design" to "breakdown, dissolution, and change" (Jackson 2014, 222). Repair, or "the subtle acts of care by which order and meaning in complex sociotechnical systems are maintained and transformed," in Jackson's work is intimately linked with ethical questions of whose work is recognised and highly valued (222). He extends the idea of repair work into both the material and social, asking (ecologically) significant questions: "Who fixes the devices and systems we 'seamlessly' use? Who maintains the infrastructures within and against which our lives unfold? … [H]ow are *human* orders broken and restored (and again, who does this work)" (Jackson 2014, 222-223)? In a similar vein, Andrew Russell and Lee Vinsel suggest that "[w]hat happens *after* innovation … is more important … has more impact on people's daily lives than the vast majority of technological innovations" (Russell and Vinsel 2016). Celebrating the work of maintaining and repairing "technologies in widespread use" which in many cases "are quite old" (Russell and Vinsel 2016). They also explicitly link the topic to questions of global inequality:

> The stalest innovation stories focus on well-to-do white guys witting in garages in a small region of California, but human beings in the Global South live with technologies too. …

> [N]ovel objects preoccupy the privileged, and can generate huge profits. But the most remarkable tales of cunning, effort, and care that people direct toward technologies exist far beyond the same old anecdotes about invention and innovation. (Russell and Vinsel 2016)

One expression of climate injustice is the disparity between celebration of the minority of technological work which deals with bringing new things into the world and the (ecologically more justifiable?) work of maintaining and rebuilding things which are already here. Reframing this hierarchy puts weight behind "an ethics of mutual care and responsibility" between humans and things, and across national borders (Jackson 2014, 231). Repair in this way is part of "the ongoing project of building more humane, just, and sustainable collectives" (Jackson 2014, 235).

Another emerging narrative can be seen in the work of Michelle Caswell, who perhaps is most famously associated with post-custodial approaches to digital preservation. Caswell makes a call for relational and meaningfully emancipatory efforts in her book *Urgent Archives: enacting liberatory memory work* (2021). Learning from her work as a critical archival studies scholar and regular contributor to the work of the South Asian American Digital Archive (SAADA) which "documents, preserves, and provides access to the rich history of South Asians in the United States," she insists that archival professionals should seek "to learn when to speak up and when to listen, when to provide direction, and when to take orders" (Caswell 2021, 7, 9). In other words, the ability to negotiate with humility between the weave of societal responsibilities and the (socio-political) constraints at play in cultural heritage institutions. A skill which will serve digital preservation practitioners well also in trying to contribute to a more environmentally sustainable practice. Caswell further considers "the redistribution of resources to repair ongoing harms" a consequential element of a just archival project (Caswell 2021, 22). Concerns about representation and relationship-building, in her view, are not enough without this "radical redistribution of the resources that make archival work possible" (Caswell 2021, 106). At the very least, I would argue, the funding available to for digital repositories and digital preservation projects need to be considered from the point-of-view of providing benefit to all of society.

DEMAND 1: TELL THE TRUTH

> It goes against the grain of human nature to step back and allow things to collapse; the urge to step in at the last minute to avert material disintegration is a powerful one. (DeSilvey 2017, 15)

In studying the work done so far on mapping the extent of environmental impact and resource use of digital repositories, I believe some important first steps have been made towards being truthful about the extent of and adaptation to climate change in archives. Understanding the situation, such as it is, arguably represents a solid foundation for being able to speak with knowledge in the future about digital preservation activities and the ICT-infrastructures that support them. The data thus collected, brings digital preservation practitioners closer to meeting such a demand, but I argue that there is a larger concern than transparency towards outside stakeholders—namely being truthful to each other about the (limited) capacity we have to preserve the tidal waves of digital content seen presently and expected in the future. Acknowledging and potentially even embracing the idea Caitlin DeSilvey expresses, that:

> [W]e need to find ways to inhabit change rather than deny or reflect it, and to find meaning in transition, transience, and uncertainty. If one accepts that we live in a world of ecological unravelling and rising seas, fragile economies and gathering storm clouds, then one is forced to admit that we may not be in control anymore, if we ever were. (DeSilvey 2017, 16)

There is (once again) a discomfort in being vulnerable in this way. Such shifting positionalities may allow the profession and the users they serve "to reckon more squarely and honestly with our machines and ourselves" (Russell and Vinsel 2016). Humility and vulnerability may prove to be more productive values to embrace than preserving a past and present into an indefinite future.

In her book *Curated Decay*, DeSilvey explores the notion of "postpreservation" heritage work, which embraced the idea that decay and erosion are not necessarily best seen as loss and destruction, but rather as changing trajectories which objects (widely conceived) can follow (DeSilvey 2017, 1). Admittedly, her approach comes from a material heritage perspective on preservation/curation, but there she brings some thoughts to the fore which may prove inspiring for more an ecological mindset in digital preservation. Perhaps there is a certain productive freedom in acknowledging that we cannot do it all: "[w]e live in a world dense with things left

behind by those who came before us, but we only single out some of these things for our attention and care" (DeSilvey 2017, 3). What happens if digital preservation practitioners engage with a "reevaluation of [the] commitment to perpetual [digital] material protection" (DeSilvey 2017, 4)? This suggestion is echoed in Pendergrass et al.'s work, where they suggest that the assumption of "a goal of zero change or loss in digital collections over time … is worth investigating and challenging" (Pendergrass et al. 2019, 186). As long as this disavowal of archival interventions is conducted in a "deliberate and considered" fashion, could it complement other approaches to better respond to "the availability of resources and the feasibility of continued investment" (DeSilvey 2017, 6)? Ben Goldman suggests that "acceptable levels of mutability" can be embraced as a strategy suitable "for the *environmental* context of our work" (Goldman 2019). Perhaps to soothe the discomfort this may cause among practitioners, he argues that this can be done "without sacrificing our archival authority *if* we are transparent about our preservation practices" (Goldman 2019). In other words, telling the truth about the limitations of the preservation work being done. Either way, it could be productive to see where this idea may lead—perhaps also informing projects in digital forensics or emulation to repair or reclaim (partially) decayed digital collections. The challenge may primarily be to strike a balance between allowing erosion and still facilitating engagements with such changing objects. Being vulnerable and honest about how digital information deteriorates and questioning the automatic impulse to step in and save digital objects from their fate may help alleviate the pressure on heritage institutions which may feel "obliged to apologize" for any decay in their data and collections (DeSilvey 2017, 9).

If we acknowledge that digital information is gradually eroding from the moment of conception, and that resource-intensive management of their fixity and preservation are best concentrated on the contexts where it delivers the most significant (societal) value to (environmental and financial) cost ratio, there would be good reason to consider what could be done about such eroding objects and collections. Embracing DeSilvey's terms, could the "palliative care," of digital information be a worthwhile pursuit?[6] There are some further potential connections between her approach and the currently dominant institutional logic of a 'golden minimum' for archival interventions (Greene and Meissner 2005): "Palliative care of a terminally ill patient involves minimal intervention—only that necessary to ensure comfort and dignity" (DeSilvey 2017, 160). It necessarily involves making difficult decisions in a situation where,

[6] DeSilvey defines palliative care as "care that seeks to relieve or soothe the symptoms of a disease or disorder without effecting a cure, particularly in end-of-life contexts" (DeSilvey 2017, 160). For more in-depth development of her idea, the chapter "Palliative Curation: The Death of a Lighthouse" in DeSilvey's book forefronts the concept.

possibly, "the carers are not in agreement" (DeSilvey 2017, 162). The decisions faced are not dissimilar to preservationist appraisal and selection concerns: "Who decides when death will be deferred, when it will be resisted, and when resuscitation will be attempted" (DeSilvey 2017, 168)? It is difficult to pre-conceive of what the potential new kinds of engagements between users and archives might result when encouraging the grieving of dead or dying data and collections.

DEMAND 2: ACT NOW

Honesty about capacity and limitations is all desirable, but how can that honest communication be turned into action—and what might acting now suggest for the archivist? It is at least a clear starting point that with honesty comes some realisation of the vulnerability of digital preservation as a project. David Rosenthal[7] observed that "[p]aper survives benign neglect very well, but bits are very vulnerable to interruptions in the money supply. No-one has enough money to preserve even a fraction of the content worthy of preservation" (2012). His work shows a long engagement with the tripartite relationship between digital preservation, financial costs and environmental sustainability. Pointing to cost developments discussed in the previous chapter, Rosenthal suggests that the costs of storage will grow significantly—even if data are "deposited together with a capital sum thought to be enough to fund its storage 'for ever,' future estimates of preservation costs will necessarily have larger margins of error than current ones" (2012). Whether financial or environmental, "every byte requires resources to ensure its reliable storage and accessibility" (Library of Congress 2014). Rosenthal argues that an environmentally sustainable perspective "may … supply new incentives for taking responsible action" (Library of Congress 2014). Responsible action necessarily means taking on a hybrid approach and considering multiple options in parallel, since we are unlikely to know any time soon which strategies prove (most) effective:

> "File compression, tiered storage, streamlining fixity checks, and eliminating duplicate or redundant data represent methods for reducing the size of a digital collection, which in turn could produce potential energy savings." (Library of Congress 2014)

Another decision which may further impede the increasing size of digital collections is stricter "justifications for mass digitization" and to reject demand for cultural heritage institutions "to digitize all analog materials" (Pendergrass et al. 2019, 192). These actions, while a good start, are

[7] David Rosenthal is also known for his work on the energy-light storage solution Durable Array of Wimpy Nodes (DAWN). See Adams, Miller and Rosenthal, "Using Storage Class Memory for Archives with DAWN, a Durable Array of Wimpy Nodes" (2011).

aligned with the mitigation approaches discussed earlier in this thesis, but even if they are not going to change the impetus for such growth there's still cause to pursue measures for "*slowing* the growth rate of digital surrogate storage" (192, emphasis added).

The idea of slowing down, taking stock of, digital preservation efforts—and the engagement with new media more generally—has resonated within many contexts where digital transformations and growing inequity are becoming more visible (Rauch 2018; Christen and Anderson 2019; Caswell 2021). Jennifer Rauch reflects that they "didn't want to do everything slow all the time, just create space for a gentler tempo that counterbalances and complements Fast Media" (2018, xii). An ecological mindset is central to her view on our relationship with digital media and the world:

> Society has gradually realized that the production, use, and disposal of digital devices have troubling consequences: depleting scarce natural resources, threatening public health, and polluting the environment. Slow Media gives us a useful framework for thinking, talking, and doing something about such obstacles to human and planetary well-being. (Rauch 2018, xxii)

Critical archival studies have tuned into the same impulse. Caswell suggests that while liberatory work "is an urgent plea, … it also demands careful, considerate, slow work" (2021, 99). Rauch and Caswell are united in their rejection of the idea that slowing down is somehow contrary to acting now. Quite the opposite:

> Urgent and slow are not opposing forces in this conception, but rather work in tandem. … These shifts take time, but we need them urgently. Slowness here is not an excuse to do nothing; it is an ethical imperative for acting now. (Caswell 2021, 99)

> Slow reform does not call for universal slowdown; it contends only that we need a meaningful counterpoint to speed. People can, and do, use fast digital technologies in the service of Slow culture. With environmental crises demanding urgent action, any media are fair play if they foster deliberation, build movements, organize alternative communities, and enable sustainable lifestyles. (Rauch 2018, 123)

To Kimberly Christen and Jane Anderson, the significance of slow archives is that they foster the "necessary space for emphasizing how knowledge is produced, circulated and exchanged through a series of relationships," and "focusing differently, listening carefully, and acting ethically" (Christen and Anderson 2019, 90). While Caswell, Christen and Anderson operationalize slowness in the service of minoritized and Indigenous peoples, I argue that slowness also has much to offer for ecological mindsets. Slowing down, without rejecting speed, could provide the

necessary breathing room to "shift from means, including the technologies that underpin our everyday actions, to ends, including the many kinds of social beneficence and improvement that technology can offer" (Russell and Vinsel 2016).

Beyond granting "people … time to gather, evaluate, and act upon information" slow archives are open-ended, they "do not presume one course o action; in fact they allow for changing course, for shifts, and for unexpected endings" (Rauch 2018, 128; Christen and Anderson 2019, 90). Taking relations between users, and records, as dominant perspective, and "a position that both acknowledges and seeks to upend systems that promote unethical, oppressive, and extractive systems" allows the slow work of creating new "modes of ethical archives" (Christen and Anderson 2019, 99). Institutions which practice digital preservation may benefit from taking a hybrid approach where more responsible preservation (following the logic of mitigation) exist in parallel with projects which explore what slowing down can bring their organisations. Taking action now, in my view, involves both elements, but there is productive potential in "efforts to build and support relationships, to help in repairing broken ones, and to create ones never previously possible" that more traditional sustainability frameworks do not offer (Christen and Anderson 2019, 99-100).

Finally, I think it worthwhile opening discussion on the objective of digital preservation: preserving (digital) information with enduring value for future use—often research. Ultimately, the desire behind research, in my view, is to improve on (understanding of) some aspect of the world. In the previous chapter I criticized the lack of an endgame for digital preservation. Acting now on these issues require at the very least a complementary drive to the future research objective. Caswell posits that, "archival endeavours should not be about documenting the past, nor even about imagining the future, … but about building a liberatory now" (Caswell 2021, 13). Rosenthal proposes that this tension between past, present and future is difficult to resolve, because it is not clear whether the value of preserved materials "outweighs the cost of keeping the data indefinitely" (Rosenthal 2012a). The danger in amassing all these materials for a future with no endgame in mind is that society could find itself "in a bad situation of being unable to afford either to keep or to throw away the data we generate" prompting further cause for a cultural change towards caution already in the process of creation and collection (Rosenthal 2012a). While such reflections are not free either, what they cost is time and space for people to collaborate on these questions. Time and space that may be made possible by exploring slowing down as adaptation strategy.

DEMAND 3: LET CITIZENS DECIDE

The idea of sharing the power to make decisions with users or the wider public are not new to archives. Cook considered this development as part of the fourth archival paradigm, community, suggesting that "[t]he challenge is to achieve more democratic, inclusive, holistic archives, collectively, listening much more to citizens than the state" than were seen in previous paradigms (Cook 2013, 116). Whether it is called "shared stewardship and collaboration," "collaborative curation," or more commonly "participatory archives," the idea has been circulated widely for a while (Cook 2013, 115; Christen and Anderson 2019, 112; Eveleigh and Benoit 2019). Often for purely practical reasons of seeking to mobilize the potential labour of volunteers and communities in processing work for which there is no budget to compensate hired staff. An understandable impulse, if not exactly admirable. But the intention communicated by collaboration and sharing require more reciprocal standpoints. Rather than extracting value, digital preservation professionals may need to "give up their recently hard-won mantras of expert, of control, of power" if the ambition actually exists to enable "archiving as a participatory *process* shared with many in society" (Cook 2013, 113, 114, emphasis in original). Cook's vision for such a community paradigm was "to find the best location for preserving the best records with the fullest context" and respecting the memory work done and the records held by communities beyond the repository—"partnering professional archival expertise and archival digital infrastructures with communities' deep sense of commitment and pride in their own heritage and identities" (Cook 2013, 116). Extrapolating this to the demand of letting citizens play an active part in decision-making around "what to keep, how to describe it, and how to activate it" is not a difficult fit (Caswell 2021, 105), but I would like to postulate that using the term citizens carries some uncomfortable undertones of privilege.[8] Perhaps for archives the term (communities of) users risks less exclusion. As for how to meaningfully foster user involvement in decision-making, both Christen and Anderson, and Caswell are convinced this involves relinquishing some curatorial power and control (Christen and Anderson 2019, 106; Caswell 2021, 108). Seeking out, engaging in, and acting on discussions with users can be one component. Christen and Anderson "promote *collaborative curation* models by adding steps to all of [their] workflows that account for multiple voices, values, and temporalities" (Christen and Anderson 2019, 112, emphasis in original).

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[8] Caswell has previously lifted Marika Cifor's notion of WEBCCCHAM which posits Citizen as one identity coupled with oppressor standpoints. See (Caswell 2019, 7) for the full breakdown.

In this chapter I brought together divergent threads of narrative that counter or seek alternatives to established doctrines of efficiency, techno-optimism and progress, through reconfiguring notions of repair, decay and slowness, with the demands of an environmental social movement. Throughout this dialogue between narratives I have taken inspiration from Caswell's ambition to imagine "a world to come" and encouraging others to join; "switch[ing] back and forth between descriptive, speculative, and normative statements" in the hope of inspiring rather than prescribing" (Caswell 2021, 94). In the following chapter, I turn to a concrete case to test some of the ideas that have come out of this and the previous chapter of the thesis. In all likelihood, there will be lingering questions from this test—and certainly elements of the narratives discussed that don't play out smoothly within the frame of digital preservation. However, my aim in this research is not to determine the exact shape of an environmentally sustainable paradigm, but to incite thought and discussion around more flourishing alternatives—an activity I believe contributes to fostering a developing ecological mindset in the work of digital preservation.

Chapter 3 – Adopting an ecological mindset in thinking about digital preservation

Environmentally sustainable digital preservation remains a distant goal. Engaging the cultural values which need correctives, and imagining those values which may productively inform a new paradigm or ecological mindset makes an important contribution, but the difficult work of fostering that cultural change will be slow and most likely non-linear. As Cook suggested, the lingering friction between prior paradigms suggest that even if an ecological mindset emerges in a real sense, it will remain in a state of perpetual tension with the goals of evidence, memory, identity, and community. In this chapter, I intend to examine a widely spread model for thinking about digital preservation practice—the NDSA Levels of Digital Preservation (from here on, LoDP)—and suggest ways in which an ecological mindset may be incorporated. The model consists of "a tiered set of guidelines and practices intended to offer clear, baseline instructions on preserving digital content at four progressive levels of sophistication across five different functional areas—storage, integrity, control, metadata, and content (Phillips et al. 2013, 216). The main driving force is to provoke thought and discussion on what including environmental sustainability might look like in this context. Encouraging engagement with these ideas and between members of the community of practice around these topics, I argue, is the most feasible way in which I can contribute to the emergence of an ecological mindset in digital preservation.

As discussed briefly in the introduction the main reason for looking at LoDP specifically is its focus on optimising resource use: "The central assumption behind LoDP is that digital preservation is about making the best use of limited resources to mitigate the most pressing risks of loss of digital information over the long term" (Owens 2018, 79). Furthermore, it has been widely influential and adopted for various uses by various digital preservation communities (Digital Preservation Coalition n.d.), and shows "considerable alignment" with other "models and frameworks" (Owens 2018, 79).[9] The connection between models and the cultural and practical reality they represent is not straight-forward. Hans Hofman has produced a significant overview of the use of modelling in recordkeeping practice, and argues that while they are potentially highly useful tools for building understanding and communicating across various fields of expertise, they remain "abstract reflections of what people do in a certain context" and necessarily simplify the realities they model (Hofman 2017, 635-6). Or as Owens phrases it: "it's critical to remember that a map is not a territory" (Owens 2018, 80). At the same time models inform and educate new practitioners, and develop through use to express common understandings of the work being done. As such engaging models for digital preservation is simultaneously a way to study and shape the

[9] Owens specifically mentions the Open Archival Information System Reference Model (OAIS), and Trustworthy Repositories Audit & Certification (TRAC).

cultural values that inform actual activities. This becomes especially relevant when considering that the NDSA membership consists of more than 140 organizations engaging in digital preservation projects, ranging "from large research universities to small cultural heritage institutions, from non-profit organizations to commercial partners" the (provisional) consensus about preservation activities inscribed in LoDP is considered prescriptive best practices (Phillips et al. 2013, 216).

THE LEVELS OF DIGITAL PRESERVATON: ORIGINS AND VERSION 2.0

The original version of LoDP was released in 2013, quickly "bec[oming] a foundational set of practices in the field, used by organizations across the globe" (Digital Preservation Coalition n.d.). One its strongest selling points is its system- and technology-agnostic approach. It sets out to "help anyone interested in long term access to digital information evaluate how they are doing in terms of mitigating risk of loss and identify concrete technical next steps they can take to move all or part of their operation to the next level" without prescribing the precise ways to execute those steps (Phillips et al. 2013, 219). In this way, the co-creators of LoDP hoped it would prove "useful not only for those just beginning to think about preserving their digital assets, but also for institutions planning the next steps in enhancing their existing digital preservation systems and workflows" (Phillips et al. 2013, 216). Already at the outset the goals were oriented around encouraging practical usability. The LoDP working group set out to produce an accessible resource with "usability across domains," that could "inform immediate procedures," and "forecast next steps … for making existing programs more robust" (Phillips et al. 2013, 216-217).

In terms of limitations of the scope of LoDP, the model takes an explicitly pragmatic approach—interested primarily in the actions involved in *doing* digital preservation, less so than the management thereof: It was "not designed to assess the robustness of digital preservation programs as a whole since it does not cover such things as policies, staffing, or organizational support" (Phillips et al. 2013, 216). This is also reflected in how they conceive its intended audience—"digital preservation practitioners, people who will be responsible for taking practical, hands-on action" (Phillips et al. 2013, 217). For the research presented in this thesis, I argue that the pragmatic orientation of the model and its link to practice is a considerable strength.

In 2018 and 2019 work was done within the scope of the NDSA Levels of Digital Preservation Revision Project—with the input of an even larger group of contributors from various organisations doing digital preservation than version 1—to update the original version and release a new and improved Levels of Digital Preservation 2.0. (Digital Preservation Coalition

n.d.) (See Figure 1.). Responses and lessons learned in the years since the original conception were incorporated—some revisions to the matrix itself, but also a wealth of supporting materials (Levels of Preservation Revisions Working Group 2019). These still conform to the original scope of "technical aspects of a digital preservation program" and does not extend to organisational aspects of policy and management.

Functional Area	Level			
	Level 1 (Know your content)	**Level 2 (Protect your content)**	**Level 3 (Monitor your content)**	**Level 4 (Sustain your content)**
Storage	Have two complete copies in separate locations Document all storage media where content is stored Put content into stable storage	Have three complete copies with at least one copy in a separate geographic location Document storage and storage media indicating the resources and dependencies they require to function	Have at least one copy in a geographic location with a different disaster threat than the other copies Have at least one copy on a different storage media type Track the obsolescence of storage and media	Have at least three copies in geographic locations, each with a different disaster threat Maximize storage diversification to avoid single points of failure Have a plan and execute actions to address obsolescence of storage hardware, software, and media
Integrity	Verify integrity information if it has been provided with the content Generate integrity information if not provided with the content Virus check all content; isolate content for quarantine as needed	Verify integrity information when moving or copying content Use write-blockers when working with original media Back up integrity information and store copy in a separate location from the content	Verify integrity information of content at fixed intervals Document integrity information verification processes and outcomes Perform audit of integrity information on demand	Verify integrity information in response to specific events or activities Replace or repair corrupted content as necessary
Control	Determine the human and software agents that should be authorized to read, write, move, and delete content	Document the human and software agents authorized to read, write, move, and delete content and apply these	Maintain logs and identify the human and software agents that performed actions on content	Perform periodic review of actions/access logs
Metadata	Create inventory of content, also documenting current storage locations Backup inventory and store at least one copy separately from content	Store enough metadata to know what the content is (this might include some combination of administrative, technical, descriptive, preservation, and structural)	Determine what metadata standards to apply Find and fill gaps in your metadata to meet those standards	Record preservation actions associated with content and when those actions occur Implement metadata standards chosen
Content	Document file formats and other essential content characteristics including how and when these were identified	Verify file formats and other essential content characteristics Build relationships with content creators to encourage sustainable file choices	Monitor for obsolescence, and changes in technologies on which content is dependent	Perform migrations, normalizations, emulation, and similar activities that ensure content can be accessed

Figure 1 – "Version 2 of the Levels of Digital Preservation" by NDSA is licensed under CC BY 4.0..

Below I will briefly discuss the structure of the 5 existing Functional Areas in order to lay the foundation for the final section which proposes a new Functional Area. *Storage* (originally Storage and Geographic Location) sets a minimum requirement of two copies, stored in separate locations, documentation of where the copies are stored, and transferring materials to a stable storage from external media carriers. Higher levels increase the required copies, diversification of storage media and locations, and demands more thorough documentation and auditing, ultimately seeking to eliminate any single points of failure. (Phillips et al. 2013, 219) Owens, who worked on the original matrix, observes that while more copies are generally considered better, "three has become the de facto standard for many cultural heritage organizations" (Owens 2018, 107).

Level 1 of the functional area *Integrity* (originally File Fixity and Data Integrity) establishes a minimum requirement of verifying any fixity information included with the content, creating such fixity information if it is not included, and virus checking all content. Subsequent

levels increase the frequency of verifying integrity, recommend backing up fixity information, more documentation and audits, as well as repairing any erroneous copies (Phillips et al. 2013, 219).

Control (originally Information Security) begins from a baseline of determining access controls for reading, writing, moving, or deleting content. Further levels require documenting and applying these decisions, logging performed actions, and periodic review of those logs (Phillips et al. 2013, 219).

The minimum requirement for the functional area *Metadata* consists of creating an inventory of contents and their storage locations, and backing up that inventory in a separate location. Progressively, the next levels require storing enough metadata to know what the content is, determining a metadata standard and repairing metadata to conform, logging preservation activities and implementing the chosen standard, respectively (Phillips et al. 2013, 220).

The final functional area, *Content* (originally File Formats) starts off with requiring that file formats and essential characteristics of the contents be documented. Higher levels go on to ask that that documentation be verified and recommending sustainable file formats to creators, monitoring for obsolescence and other threats to format, and ensuring that content can be accessed by performing preservation actions (Phillips et al. 2013, 20, 220).

While the main use of the LoDP guidelines is as a support for taking first steps or improving on digital preservation activities, the original documentation proposed a set of "[o]ther possible uses," one of which is particularly relevant for what follows, namely its use in assessment both of compliance with best practice and points of possible improvement (Phillips et al. 2013, 220-221). The authors specify here that in assessments the levels may be viewed primarily as "progressive stages or levels of service" (Phillips et al. 2013, 221). The notion that these guidelines have also seen use in the assessment of digital preservation practice in some organisations further supports the idea that they may provide useful guidance for institutions looking to do digital preservation in more environmentally sustainable ways.

THE LOGIC OF PROGRESS AND PRODUCT: A REFLECTION

> "The revision has realigned the levels so that they have a stronger progressive implication, and each level naturally builds upon the prior one *to guide a repository into greater maturity*." (Levels of Preservation Revisions Working Group 2019, emphasis added)

At a few points in the above description of the LoDP, the logic of progress and accumulation I discussed in chapter 1 is made explicit. Levels, as well as "the overall structure" of the model is "progressive" (Phillips et al. 2013, 218). In this sense, the model aligns well with the dominant perspective of the More Product, Less Process approach introduced by Mark Greene and Dennis Meissner which has come to inform at lot of digital preservation work in recent years (2005). In a section named "The Unfinished Revolution", Trevor Owens discusses More Product, Less Process "as a kind of progressive enhancement approach to collections work" (Owens 2018, 132-133). They set out to address the issue of slow processing of collections resulting in unprocessed (and for that reason often not made available) backlogs (Owens 2018, 132). The strength of their approach stems from the idea of "the golden minimum" or "the best level of arrangement and description performing the least amount of work to get records into a format that makes them usable" (Owens 2018, 133). Bypassing low-level descriptions, has made processing of collections a lot less "inefficient" (Owens 2018, 133), and following this maxim cultural heritage institutions can and do "expend far less effort and start moving content out to users much more quickly" (Owens 2018, 134). The idea relies on the techno-optimist attitude of saving it for an expected future moment when new technology and methods can solve the problem of further processing:

> While it's possible to spend a lot of time and energy sorting out these relationships and deciding which copies should be kept, in keeping with the MPLP principles, it's likely best to hold on to a lot of these variants and stay open to exploring computational methods for better relating and connecting them in the future. (Owens 2018, 150)

I am reminded here of Rosenthal's concern with the possibility of "a bad situation of being unable to afford either to keep or to throw away the data we generate" (Rosenthal 2012a) While making more materials available sooner is not in and of itself a problem, the push to provide access to ever-increasing materials and leaving further decisions about what is worth keeping for the future is emblematic for the borrowing of resources from future generations in the name of service. Such borrowing from an uncertain future represents what Caswell calls "a temporal orientation for

archivists, who have framed their work for the long haul of a future that might never come" (Caswell 2021, 107).

If there was not an ideology of 'More Product' behind these new options for processing materials, the situation may be more favourable. It is beneficial to have the option to sparingly and consciously chose certain collections for their established future value and establishing minimal accessibility early on. But the implication is clear, rather than making decisions about deaccessioning backlogs, they are to be kept and made available to add to the repository product range. Implying that more data and access is always a good thing. This problem returns in the Levels of Digital Preservation which lacks significant guidance or counters to suggest when the lower levels may be perfectly sufficient: the proposed "path for enhancement" arguably suggests "that an organization should strive for Level 4 in all cases that resources allow" (Pendergrass et al. 2019, 181). Pendergrass et al. continues to suggest that "most organizations continue to strive for optimal digital preservation," without "established metrics … for evaluating the success of digital preservation" (181). This techno-optimistic attitude promotes the view that more product results in more progress. The idea of (desirable) linear progress does not only emerge from the language used—levels, progress, greater maturity—but also from the visual/aesthetic design of the matrix—as you reach the higher levels of digital preservation excellence you move out of the red and find yourself reassuringly in the green. If the model was indeed intended to suggest that these levels should be variably applied—perhaps per collection, or even object—to better balance the impulse to keep with the cost of preservation, both language and design would do well to better invoke that tension.

PROPOSING AN ECOLOGICAL MINDSET: MODES OF DIGITAL PRESERVATION

Based on the above discussion and previous chapters, this section will propose a multiple approach for infusing the Levels of Digital Preservation with an ecological mindset, taking inspiration from the rejection of efficiency, techno-optimism, and progressivist narratives from chapter 1 and the demands to tell the truth, act now, let citizens decide, and climate justice from chapter 2. Both elements of the approach could potentially be implemented simultaneously, but my intention has been to make them function separately. The first element is to develop a sixth functional area named Environmental Sustainability which maps the themes of my research onto Levels 1-4. The second element is a set of suggestions for infusing aspects of an ecological mindset that have emerged throughout this thesis – seeking to balance out some of the, I argue, undesirable narratives from the current version.

Functional Area	Level			
	Level 1 (Know your content)	Level 2 (Protect your content)	Level 3 (Monitor your content)	Level 4 (Sustain your content)
Environmental Sustainability	Map the environmental impact of your activities Tell the Truth	Seek to mitigate the environmental impact of your activities Act Now	Evaluate your efforts Let Citizens Decide	Explore beyond mitigatory measures Climate Justice

Figure 2 – Functional area "Environmental Sustainability" (Version 1) for the NDSA Levels of Digital Preservation.

The Functional Area of Environmental Sustainability that I have sketched (See Figure 2.) adheres to the sequential logic only in so much as that the lower levels support and strengthen the approaches that can be taken to higher levels. Level 1, knowing your content, proposes that the minimum requirement or first steps towards improving environmental sustainability involves mapping the scope and environmental impact of your digital preservation activities. Even with a provisional and incomplete map you are better prepared both to tell the truth about the ecological strengths and vulnerabilities of your organisation and for Level 2. Level 2, protect your content, suggest you take direct action to mitigate your organisations environmental impact. These efforts are logically more likely to be successful if you've already worked on implementing Level 1. Having taken actions to improve, Level 3, monitor your content, requires you to document and evaluate those efforts in order to see if there are areas on which you can improve further. At the very least, this stage would be a relevant stage to involve your communities of users: allowing them to engage with the results of your mapping and mitigation work. Note that despite this division, involving outside communities in the decision-making process at other stages is also encouraged. Level 4, sustain your content, encourages organisations and individuals that practice digital preservation to explore beyond their experiences with mitigatory measures. Appropriately through the lens of some of the themes explored in chapter 2 (repair, decay, slow media), but importantly this level should be considered as a perpetual project to improve the just and equitable transition of your organisation into environmentally sustainable futures.

Functional Area	Mode			
	Know your content	Protect your content	Monitor your content	Sustain your content
Environmental Sustainability	Map the environmental impact of your activities Tell the Truth	Seek to mitigate the environmental impact of your activities Act Now	Evaluate your efforts Let Citizens Decide	Explore beyond mitigatory measures Climate Justice

Figure 3 - Functional area "Environmental Sustainability" (Version 2) for the NDSA Levels of Digital Preservation.

The second element (See Figure 3.) proposes something of a reconsideration of the design choices which reinforce some of the questionable narratives critiqued in chapter 1 (efficiency, techno-optimism, progress). This example builds off the idea that a new ecological mindset in digital preservation would demand that environmentally sustainable thinking not be relegated to a separate specialised area, but suffuse the activities throughout the levels of all functional areas where appropriate. For *storage* this may include prompts to think of whether fewer copies would suffice for the collection or record at hand. For *integrity*, *metadata*, and *content* it may be more productive to consider—for your institutional or individual context—whether any level of mutability/decay is acceptable and whether this could even promote other ways of engaging with the materials concerned. For the functional area *control*, I think it is reasonable to consider whose rights to manage access controls are promoted. In the case of records and collections which represent a cultural value for minoritized or Indigenous peoples or that have been collected in processes of extraction—returning the right to make decisions about access controls can promote forms of justice and inequity by relinquishing power and authority (even if it is in a limited scope). Finally, the proposal for a Version 2 of Environmental Sustainability below features some visual/design changes to lessen the sensation of a hierarchy of maturity and quality that the original design inscribes through such aesthetic and linguistic choices: (1) Levels have been changed to Modes, and the numbering removed to indicate that the levels can be used in a somewhat modular fashion and that efforts in any of these modes are not wasted; (2) The colour gradient has been replaced with a reassuringly even shade of green to remove or weaken the imperative to move towards the right end of the table.

While these efforts to adapt the NDSA Levels of Digital Preservation hardly constitute a complete rejection of techno-optimist or progressivist narratives, and is not in and of itself enough to bring about a (r)evolution towards an environmentally sustainable archival paradigm I hope that it can at least encourage some thought and discussion among digital preservation professionals and others interested in the tension between preserving digital information and an ecological mindset which takes as its main objective the flourishing of all, now and in the future.

Conclusion

When first setting out on this journey to explore and imagine the possibility of an environmentally sustainable digital preservation practice, climate change and ecological crises had been joined by the (still ongoing) global pandemic. As both work and social life transitioned further towards the digital realm, images from around the globe reminded me of the inequalities in opportunity and risk. For me, these developments have posed a powerful reminder of the necessity of thinking in terms of connections and relations, humility and curiosity towards others, and being open to new opportunities to improve what I can from the position I inhabit. An ecological mindset for digital preservation and beyond may require several of these qualities, in addition to challenging some deep-rooted values and embracing others. With this thesis I have attempted to follow the example of Caswell, to "both describe what archivists are doing and speculate about what they *should* do" (Caswell 2021, 94). I have argued that digital preservation practitioners need to move beyond the idea of innovation through technical means as the 'solution' to the (multifaceted) 'problem' of environmental sustainability. It is no longer feasible to buy into "the fantasy of full memory" (Creet 2002, 2) and simultaneously take the ecological and social responsibility of cultural heritage institutions seriously.

Another constraint, which this thesis has had the privilege to be less bound by, is the budgetary constraints and cuts which have cultural heritage professionals scavenging for ways to do more with less, a situation where technical solutions have a lot to offer through computational approaches that allow for work at unprecedented scale and with impressive ingenuity. I finish this thesis by wondering if this does not contribute to the logic from governing and funding bodies outside the archive that with less investments archivists seem to get more efficient and less wasteful—leaving little room for slowing down, taking the time to make well-measured decisions about the multiple ways contemporary challenges can be approached. A culture which encourages having both eyes on efficiency and measurable progress is at the very least unlikely to make much room for ecology and environment in the decision-making process. What governing principals and policy may need to change or emerge to accommodate this new ecological mindset? What ramifications would embracing decay, slowing down, or repairing instead of inventing have for future funding and for the societal impact of archival endeavours? Can better ways be developed to share custodial responsibilities and privileges justly and equitably with people outside institutional walls? These are all questions and themes which emerged while writing this thesis, and which could provide fruitful areas of inquiry for future research.

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