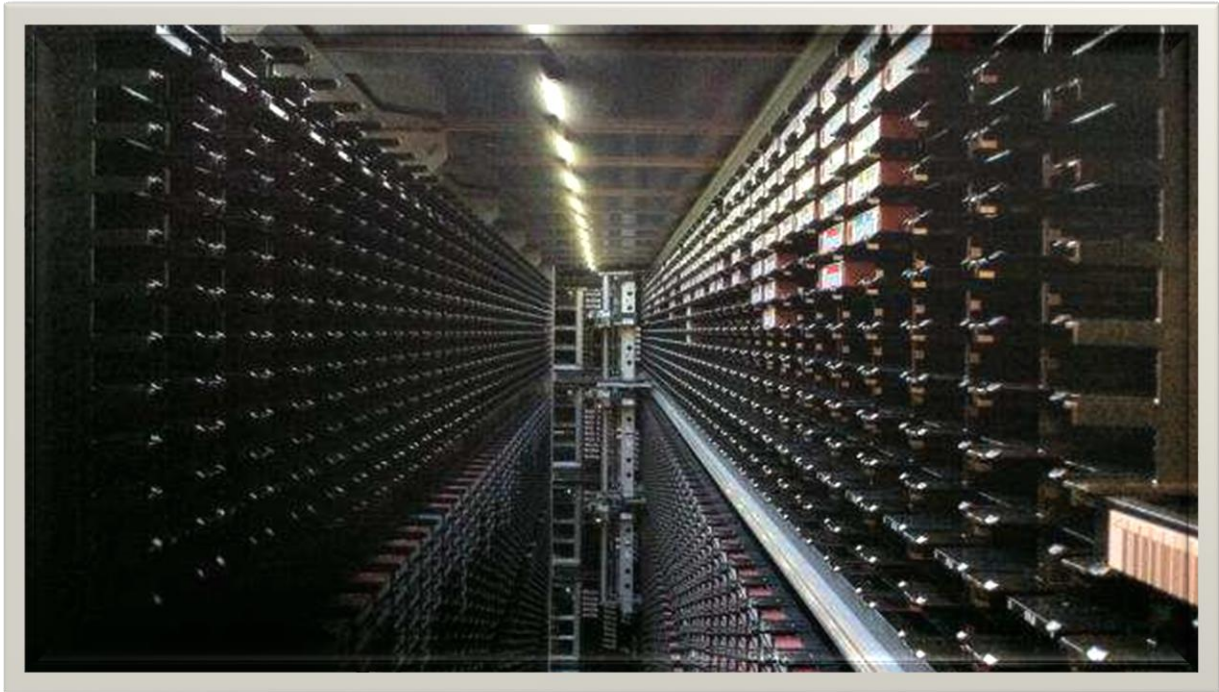# Preservation for the Future

Understanding the materiality of digital, audio-visual heritage

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Table of Contents

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Abstract

This research has set out to analyse the environmental impact of digital, audio-visual heritage preservation. Due to the rapid developments in this field, there is an urgent need to create insight into the material consequences of using this digital space. This research has therefore executed an analysis of the policies of both the *Netherlands Institute for Sound and Vision* as well as *EYE Film Museum*, to understand how they approach environmental concern during the preservation of audio-visual heritage. Both archives work towards sustainable preservation, meaning the long-term safeguarding of their collections, but how environmentally sustainable is this process? To answer this question, this research has focussed on the concept of materiality. Through a New Materialist perspective that acknowledges non-human agency, this research has been able to execute a practical analysis of the matter involved in digital preservation. This framework simultaneously provided the opportunity to reflect upon the underlying relationship between our cultural practices and its materiality, between the human and the non-human, and to consider possibilities for more sustainable practices.

This research found that environmental considerations are currently not present in either preservation policy, partly because materiality and its agency are not sufficiently acknowledged. Through this New Materialist approach, this research was able to reflect upon the intra-action between material agency and human agency in the archive and highlight where the preservation of these collections is dependent on matter. This showed that materiality is approached purely as a resource, as something that can be used to serve the interests of human actors within the archive. Instead, this research argues that this agency should be acknowledged so that the collections' dependency on this matter becomes clear. Only then, balanced considerations between interests can be made during the preservation process. Because environmental sustainability is inevitably tied to the sustainability of the collections, this research argues that there is just one form of sustainability. Only when this is acknowledged, both the collections as well as our environment, can be preserved for future generations.

"To communicate with one another, we also inadvertently communicate our dismissive relation to the humans and natural environments who pay the terrible price for its efficiency, even for its poetry."

- Sean Cubitt [1]

[1] Sean Cubitt, *Finite Media: Environmental Implications of Digital Technologies* (Durham: Duke University Press, 2017), 6.

Introduction

Prologue

When the *Images for the Future* project started in 2007, its main incentive was described as a "rescue mission" of Dutch audio-visual heritage. The state of this heritage, the project argued, was worrisome to say the least and this project would be a widespread, multi-institution effort to safeguard these collections and further develop their accessibility. They argued that much of the audio-visual analogue collections in the Netherlands where prone to decay in the upcoming years, due to the physical carriers breaking down, which was risking the cultural history they contained. A large-scale digitisation project would provide a solution to preserve these objects, while also adapting these collections to suit the digital age. As the end report of the project described, the problem was not only the decay of the objects, but also the inaccessibility of the overall analogue collections. The analogue carriers were only accessible for visitors of the archive and provided a challenge to search through. The digitisation project meant that attention could also be directed towards the development of a digital infrastructure with which the collections could be accessed and searched through. It presented itself as the perfect solution, to safeguard Dutch audio-visual heritage while opening the archive to the wider public.

Because the archive is not just a place where both personal, as well as national history can be found. It is a place where disciplines meet, and where knowledge is produced. Audio-visual heritage especially, has the power to quite literally show to us who we are, or to let us listen to that which has been. It can reflect the past directly, while also reflecting upon the medium with which this becomes accessible. In our highly mediated modern lives, one can learn from the development of these media themselves, as well as their position in our societies. It is therefore important that archives protect this heritage and do everything in their power to preserve these collections. Digitisation, the end publication of the project described, was one way of achieving the goal of "sustainable preservation".[2] A term that entails all actions and practices that will guarantee the preservation and accessibility of audio-visual collections for future generations. In sum, preservation is sustainable, in this definition, if the process assures the future of the audio-visual collections. What the Images for the Future project argued, was that digitisation was one way to achieve sustainable preservation, through eliminating the material, analogue carrier and preserving the heritage digitally.

However, the term "sustainable" is inherently linked to its colloquial use of environmental sustainability and the pressing issue of climate change. The environmental debate over the past few years has shown that society should not only worry about saving their heritage for future generations, but that they should actively ensure that the environment is protected if we want our children to inhabit

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[2] Thijs van Excel et al., *Beelden van het Verleden. 7 jaar Beelden voor de Toekomst* (2015).

a similar earth as our own. In June of 2022, a group of Dutch climate scientists re-instated the need to minimize global warming but also emphasised that the goals that have been set in international organisations over the years, to minimize the earth's temperature rise to 2 degrees Celsius, will fail.[3] There is a pressing urgency to discuss environmental sustainability in all sectors. This research therefore started with the practical question if, and how, these two forms of sustainability could co-exist within the archive, and thus if the process of preserving these audio-visual collections for the future, could simultaneously be environmentally sustainable.

At the same time, the language used in the Images for the Future project to describe this transition from analogue carriers to digital storage reflected the underlying issue, that of materiality and our engagement with it. When digitising these collections, the analogue carrier might be eliminated from the process, but that does not mean that digital storage does not consist of matter. It has just become harder to see. As Sean Cubitt described in his book *Finite Media,* all communications are inherently material. He writes:

> "Media are finite, in the sense both that, as matter, they are inevitably tied to physics, especially the dimension of time, and that their constituent elements – matter and energy, information and entropy, time and space, but especially the first pair – are finite resources in the closed system of planet Earth."[4]

Digitisation might feel like these archives are immaterialising their collections, but they are still dependent on resources to ensure the future of these collections. Resources that are limited, and whose accumulation can impact our environment. It is this materiality that will be the centre of this research, which will allow engagement with the problem on two levels. First, a focus on the materiality of digital preservation will create room for a practical analysis of where this process impacts the environment. Secondly, this will create the possibility for a more theoretical reflection of the relationship between the human and the non-human, between our cultural practices and their material dimension.

From a societal point of view, it is important to research this environmental impact, as these archives are often public institutions, or are at least safeguarding public heritage while receiving public funding.[5] This comes with a responsibility to engage with the issues that concern us all, and that are at the centre of our communities. As this research will show, few problems are currently more pressing than climate change. It would therefore be undesirable for public institutions to knowingly contribute to the environmental concern that is at the centre of public debate. An additional motivation is that these archives are also actual buildings that are centred in the middle of local communities. Their use of

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[3] Marijn Duintjer Tebbens and Yfke Nijland, "Klimaatwetenschappers: beperken opwarming aarde gaat mislukken," NOS, last modified June 17, 2022, https://nos.nl/nieuwsuur/artikel/2433051-klimaatwetenschappers-beperken-opwarming-aarde-gaat-mislukken.
[4] Sean Cubitt, *Finite Media,* 7.
[5] Van Excel et al. *Beelden,* 8-9.

resources, in the form of energy or water for example, directly affects the infrastructure of these communities, and it is therefore the responsibility of the institution to do so responsibly. Just recently, a court case was initiated because of the development of *Meta's* new data centre in the city of Zeewolde.[6] While we are not always engaging with the materiality that is underneath the social media sites that we use, both *Facebook* and *Instagram* are entirely dependent on data centres like these. The local Zeewolde community, however, realised that the amount of energy and water that this centre would require, would directly affect their own infrastructure and reserves.[7] While on a different scale, this form of digital storage is not that different from the digital preservation of audio-visual heritage. These archives should therefore engage with this topic and actively work on viable solutions. For this, more information on the actual impact and possible sustainable practices is necessary. In the end, this presents an ethical dilemma. It is of utmost importance to preserve audio-visual heritage, both for the production of knowledge as for the formation of identity and to visualise our past. But is it possible to do so, in an environmentally sustainable way?

From a more theoretical point of view, this research is important as it will contribute to the academic debate surrounding digital preservation in the Netherlands. While environmental sustainability in the media sector is at the centre of much research from authors like Cubitt, Laura Marks and Jussi Parikka, the predominant focus seems to have been directed at the production, distribution, and consumption phase of the media industry.[8] This last phase, which takes place in the archive, has been rather underexposed. As this research will show, it is not that this debate does not exist, but that the developments within audio-visual preservations have followed each other so rapidly, that there has been little time to fully investigate their consequences. As the literature will show, the importance of heritage preservation is acknowledged by many. This research, however, will also show that an awareness of its environmental impact is starting to spread, resulting in an ethical debate between the value of cultural heritage and the impact of this preservation. This research will therefore contribute to this debate and present an orientation on the current state of environmental considerations within Dutch, audio-visual archives. It will bring these two sides together as it will engage with the problem of environmental impact, without losing sight of the importance of audio-visual heritage. Because, as Richard Maxwell and Toby Miller argue, media scholars have an obligation to study the materiality that underlies the "textuality, technology and/or reception" that are often the centre of our research.[9] Not only because of its environmental strain, but to understand cultural practices in relation to our environment.

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[6] Teake Dijkstra, "Ondanks protesten kan Meta aan de slag met datacenter in Zeewolde," AD, last modified December 17, 2021, https://www.ad.nl/binnenland/ondanks-protesten-kan-meta-aan-de-slag-met-datacenter-in-zeewolde~ad849535/.

[7] "Milieu-commissie: Wacht nog met vergunning datacener Zeewolde," RTL Nieuws, last modified August 24, 2021, https://www.rtlnieuws.nl/tech/artikel/5249772/datacenter-zeewolde-commissie-milieu-effecten-vergunning-nog-niet-geven.

[8] Cubitt, *Finite Media;* Laura Marks, "Let's Deal with the Carbon Footprint of Streaming Media," *Afterimage* 47, no. 2 (2020): 46-52; Jussi Parikka, *Electronic Mediations, Volume 46: Geology of Media* (Minneapolis: University of Minnesota Press, 2015).

[9] Richard Maxwell and Toby Miller, *Greening the Media* (Oxford: Oxford University Press, 2012), 10.

Case studies and demarcations

In order to do so, this research will investigate the policies of two Dutch audio-visual archives, namely *The Netherlands Institute for Sound and Vision* in Hilversum and *EYE Film Museum* in Amsterdam. Both archives where part of the Images for the Future project, and therefore present fitting case studies, as this project was a unique collaboration to digitise across the borders of individual institutions.[10] Because of this collaboration, knowledge could be shared, speeding up the development of the digital infrastructure in both institutions. This makes the Dutch audio-visual heritage landscape suitable for analyses of environmental impact. Images for the Future ended in 2014, and it is now time to research how the workflows in the two archives have developed and which policies are in place to prepare for the future of digital, audio-visual heritage. While both institutions have an elaborate collection of audio-visual, and non audio-visual objects, the inclusion of both archives in this research attempts to intercept any important medium-specific information, as Sound and Vision predominantly specifies in television history, while EYE focusses on Dutch film heritage. Both media have inherent characteristics that influence how they should be preserved, like the quality the objects need or the amount of storage space they require. For this reason, both archives have been included.

In relation to these case studies, three demarcations should be addressed. First, it should be noted that this research will often address both film and television when discussing the preservation practices of both EYE and Sound and Vision. However, both institutions archive other forms of media as well, like radio, web-videos, or magazines, to name just a few. The exact analysis of the preservation of each medium, however, will lie outside of the scope of this research. As for now, it is most important to analyse the overall digitisation policies and influx of digital-born material into the archives and to see if environmental considerations are, or can be, part of this process. Secondly, this research will not address the environmental considerations during the preservation of analogue audio-visual collections. As this research will show, a lot of time, labour and finances are currently being invested in digitisation of the audio-visual archive and it is therefore important to focus on what this means for the environment, before further investments will be made. Lastly, due to its focus on two Dutch archives, this research will not be able to prevent some form of nation-specificity, as many practices of the two institutions are centred within specific Dutch legislations and funding structures. However, The Netherlands is not an exception in this, as this will be the case for most countries and their audio-visual archives. Future research in other countries, both comparatively and from a transnational perspective, is therefore encouraged to fully understand how nation-specific legislation influences the daily practices and environmental concerns of the audio-visual archive.

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[10] "Beelden voor de Toekomst," Beeld en Geluid, last accessed July 22, 2022, https://www.beeldengeluid.nl/kennis/projecten/beelden-voor-de-toekomst.

Research Questions

As this research sets out to investigate the domain of environmentally sustainable digital preservation, it must engage with what environmental impact actually is by analysing the materiality involved in this form of storage. This research will therefore answer the question: What matter is involved with the process of digital, audio-visual heritage preservation? To answer this question, this research will start with a more general reflection upon the environmental impact of the media industry and digital preservation, followed by a review on the importance of audio-visual heritage. Together, this will outline the two sides to this problem. Lastly, this research will engage with this issue on a more practical level and analyse how the two case studies approach this environmental impact within their digital preservation policies. In sum, this research will answer the following three sub-questions:

1.) What is the environmental impact of preserving digital, audio-visual heritage?
2.) What is digital, audio-visual heritage and how can it become more environmentally sustainable?
3.) In what way do the Netherlands Institute for Sound and Vision and EYE Film Museum consider environmental impact the preservation process of their digital, audio-visual collections?

Together, answers to these questions will provide insight into the problem on two levels. First, this research will present a practical study of the impact of digital, audio-visual preservation and possible solutions to this problem. Second, this research will engage with this problem from a more theoretical perspective and reflect upon the relationship between our cultural heritage and its materiality. Through providing insight into matter involved in digital, audio-visual preservation, this research will be able to reflect upon the underlying relationship between ourselves and our environment, and hopefully present a first orientation on possible environmentally sustainable practices.

Literature

In order to answer these questions, this research contains an extensive review of the current literature on the subject both to understand the problem of environmental impact as well as the importance of audio-visual heritage. The initial stages of this research made it clear that academic research on the problem of unsustainable digital preservation was still in its early stages. This research therefore attempted to understand the changes that this practice has undergone in the last decade, and to clearly

set out what audio-visual heritage is, and with which incentives this preservation process is designed. To understand the notion of heritage, this research has extensively engaged with Caroline Frick's work on "The Politics of Preservation".[11] Her description of how heritage is a construction, and historically tied to the nation state made it possible to investigate the archive as a public institution, as well as its connection to government, connections that profoundly influence the final goals of the archive. Additionally, this has been supplemented with work by Sonja de Leeuw on the position of audio-visual heritage in relation to history.[12] As something that can both "record as well as represent the past" at the same time.[13] This makes it possible to engage with the question what audio-visual heritage actually is, and why it is worth preserving in the first place. This section will also engage with work by Benedict Anderson as well as Chiara de Cesari and Ann Rigney, to analyse the role of cultural heritage in relation to the formation of 'imagined communities' and the reinforcement of the idea of a shared past.[14] This will help explain why audio-visual archives embedded in the idea of national ownership and why they are therefore often public institutions or tied to public funding.

This research will additionally engage with research on environmental sustainability in the media industry. This review will discuss the current awareness of the issue that is present but will also show that many scholars are emphasising the responsibility of both the industry as well as researchers to engage with the environmental impact that is inherently tied to the media we produce, consume and study. Specifically, because it is those media that are used to spread environmental awareness and stimulate people to engage with the problem. Maxwell and Miller's book *Greening the Media* has served as a primary incentive to focus on the materiality involved, as they write how "media are, and have been for a long time, environmental participants" and how this connection makes it the responsibility of media scholars to research the materiality intertwined with the texts they study.[15] A similar argument is made by Pietari Kääpä, as well as Janet Walker and Nicole Starosielski, who all argue that the representational aspects of media, those sides that are able to contribute to environmentally sustainable change by spreading information, cannot be seen apart from their production and own contribution to the problem.[16] This research specifically engages with the differentiation made by Kääpä between media's "brainprint", meaning the ability to convey ideas and information and therefore influence "individual behaviour and policy", and its "footprint".[17] He too, argues that media scholars have often been too involved with what the media can possibly do, and how

[11] Caroline Frick, *The Politics of Preservation* (Oxford: Oxford University Press, 2011).

[12] Sonja de Leeuw, "European Television History Online: History and Challenges," *VIEW Journal of European Television History and Culture* 1, no. 1 (2012): 3-11.

[13] De Leeuw, "Television," 6.

[14] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso Books, 1991); Chiara De Cesari and Ann Rigney, "Introduction," in *Transnational Memory: Circulation, Articulation, Scales,* ed. Chiara De Cesari and Ann Rigney (Berlin: De Gruyter, 2014).

[15] Maxwell and Miller, *Greening,* 9.

[16] Nicole Starosielski and Janet Walker, *Sustainable Media*, ed. Nicole Starosielski and Janet Walker (London and New York: Routledge, 2016), 2-19; Pietari Kääpä, *Environmental Management of the Media: Industry, Practice* (New York: Routledge, 2018): 2-5.

[17] Kääpä, *Environmental Management,* 2-5.

it can be used, instead of engaging with its "material practice".[18] The work done by these authors will therefore serve as a motivation for this research, as well as an orientation on how the issue of environmental impact has been approached so far. This will allow this research to argue that a focus on the materiality of the digital preservation process, and therefore an overall reflection on the relationship between cultural practice and its materiality, will result in more environmentally sustainable practices.

While the debate on environmental sustainability of digital preservation is still in its early stages, recent years have seen much engagement with the environmental footprint of other stages in the media industry. This research has therefore also expanded its attention to understand how this problem is approached, both by industry professionals as within the academic debate, during the production, distribution, and consumption of media. A notable example of this is Hunter Vaughan's book *Hollywood's Dirtiest Secret*.[19] Vaughan has provided great insight into how an eco-critical text as well as production analysis of a film can provide insight into how materiality is approached in the industry, an approach categorised by waste and excess. Analyses like this are of great use to this research as they also reflect upon this relationship between culture and materiality, presenting common threads in all phases of the media industry. At the same time, fruitful debates have been taking place on the transition from hardware carriers like DVD, to streaming services for films and television. Many authors, among which Aditya Nair, Gregory Auerbach and Steven Skerlos, state that streaming uses a lot less energy as it is more efficient, and that it would therefore be the greener option.[20] At the same time, scholars like Laura Marks argue that this statement is outdated and that this research insufficiently acknowledges the increase in consumption.[21] While our devices might be becoming more and more efficient, we are also using them more, eliminating any environmental gain that might be present, a process also called the "Jevon's Paradox".[22]

By analysing these debates in other stages of the industry, two main points of attention have been highlighted for this research. First, that the Jevon's paradox should be considered in the archive as well. As technology is rapidly evolving, storage size is exponentially growing, and the hardware itself is becoming more efficient. It should be considered if archives are approaching this in a similar way as many individuals, by simply storing more. Secondly, in most of these distribution and consumption analyses that argue that digital streaming would be more sustainable, the focus has been on energy use, and sometimes specifically CO_2 emissions. In most cases, these articles did not address other forms of environmental impact, like mineral mining, rest-heat damaging ecosystems or e-waste created in these processes. This made it clear that there should be a focus on the entire lifecycle of

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[18] Kääpä, *Environmental Management,* 2-5.

[19] Hunter Vaughan, *Hollywood's Dirtiest Secret: The Hidden Environmental Costs of the Movies* (New York: Columbia University Press, 2019).

[20] Aditya Nair, Gregory Auerbach, and Steven J. Skerlos, "Environmental Impacts of Shifting from Movie Disc Media to Movie Streaming: Case Study and Sensitivity Analysis," *Procedia CIRP* 80 (2019): 393–398.

[21] Marks, "Carbon," 47.

[22] Keith Pendergrass et al.,"Toward Environmentally Sustainable Digital Preservation," *The American Archivist* 82, no. 1 (2019): 172.

hardware if this research wants to understand the size of this problem and the underlying causes. This research will therefore use the term "non-mediatic materialities", coined by Starosielski and Walker, to analyse all materiality involved.[23] This will make it possible to argue that, while digital storage might feel immaterial, media scholars should engage with the entire hardware lifecycle if we want to understand its relationship to these cultural practices, even if the matter involved is now further removed from the process itself than it was with analogue storage.

While still a limited debate, this research will also extensively engage with the current work on environmental sustainability in the digital archive. What this research found is that this debate predominantly consists of orientating, quantitative research like that by James Faulkner, Liuxing Lu and Jiangping Chen, for example.[24] In their article "Archivists' golden egg" they analyse if environmental factors divided into several categories are mentioned in different archival policies. While very insightful, this quantitative approach predominantly provides an overview of awareness per category. This research attempts to supplement these insights, with a more qualitative approach to the overall problem of environmental impact. Not just by reflecting upon all materiality involved, but also on the outside organisations that are connected to the archive. This will create room to analyse the connections between the preservation policies and the archive's obligations and agreements with these organisations. Only then, this research will be able to reflect on the way the interests of these other organisations are influencing the decisions for certain methods and processes within the archive.

Within this work on environmental impact of digital preservation, two authors will have a predominant position within this research. First, Linda Tadic who gave an insightful presentation at the *Association of Moving Image Archivists* conference in 2015, and secondly, Keith Pendergrass et al. who have published the article "Toward Environmentally Sustainable Digital Preservation".[25] Tadic presents a clear overview of the different forms of impact that are directly related to the process of digital, audio-visual preservation. She distinguishes three specific areas of impact in this process, which will be used in this research. The first being the destruction of the now redundant analogue carrier, the second relating to the use of electricity to keep the hardware running and to access the objects and lastly, the destruction of that hardware once the objects are migrated every few years.[26] As stated, this research will have attention to the non-mediatic materialities involved, so will therefore be aware of the minerals embedded in this hardware, and the extensive problem of e-waste involved in its inevitable destruction. Additionally, Tadic presents the different types of carriers, and their benefits for both preservation as well as environmental sustainability, a summary this research has benefited greatly from.

The same goes for the work by Pendergrass et al. In their article, the authors clearly outline the

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[23] Starosielski and Walker, *Sustainable Media*, 13.

[24] James Faulkner, Liuxing Lu, and Jiangping Chen, "Archivists' Golden Egg: Environmental Sustainability Practices of Archives," *The Electronic Library* 39, no. 2 (2021): 258–80.

[25] Linda Tadic, "The Environmental Impact of Digital Preservation," slides, last accessed January 13, 2022, https://www.digitalbedrock.com/resources-2; Pendergrass et al., "Sustainable."

[26] Tadic, "Environmental Impact," slide 10.

issue of environmental impact through the ICT used within the digital preservation process.[27] Secondly, they argue that to change this, interim solutions like renewable energy are not sufficient. Instead, they argue, the paradigms under which the digital objects are preserved should shift, into one where there is room for environmental considerations. They specifically present different questions archives can follow to review their practices in the areas of "Appraisal," "Permanence" and "Availability", a categorisation this research will also follow. While Pendergrass et al.'s work has been of significant importance for this research, there are two specific points of attention where this research will attempt to complement their work. First, it will approach the subject from a different theoretical framework, highlighting the underlying relationship between culture and materiality and working from a more theoretical perspective. Secondly, Pendergrass et al. present very applied questions that archives can ask themselves to work within a more environmentally sustainable paradigm. This research, because of this theoretical reflection, will provide a different approach to understand how these paradigm shifts can be accomplished. One where there is more attention for the entire network of obligations and responsibilities surrounding the archive, as well as for its relationship with materiality.

Theoretical Framework

While this research will work from Pendergrass et al.'s article and understand how their suggested paradigm shifts can be accomplished, this research attempts to go a step further than a practical reflection on environmental impact of digital preservation. While it will also address this applied perspective to the problem, this research will centre around the relationship between culture and materiality and how this has changed in the digital era. As stated, this reflection has left from Cubitt's notion of media as material, and therefore finite.[28] When accepting that all media, digital or not, consist of matter, we must accept that we cannot accumulate, use, and throw away this matter to an unlimited extend. As Cubitt writes: "To create new materials means using up a finite stock of energy sources. The obsessive accumulation of everything that characterizes our era has limits."[29] This research argues that digital storage, both for individuals but also within cultural practices, is one of these aspects that characterises our era. Therefore, while this research will also practically analyse where digital preservation impacts the environment, the realisation that this matter is finite will allow for a reflection upon the underlying relationship between cultural practices and their resources.

This research has therefore started with the notion of materiality, and for this the work of Parikka has been essential. His book *Anthrobscene* has specifically detailed what this research addresses

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[27] Pendergrass et al., "Sustainable" 170-176.
[28] Cubitt, *Finite Media.*
[29] Cubitt, *Finite Media,* 7.

when it speaks of matter.[30] Specifically because the intention of this analysis is to not only address where hardware is used in the process of audio-visual preservation, but to involve the nonmediatic materialities as well. As Parikka writes: "Hardware perspectives are not necessarily hard enough, and if we want to extend our material notions of media thoroughly toward deeper materialities and deeper times, we need to be able to talk of the matter that contributes to the assemblages and durations of media as technology".[31] In practice, this means that Parikka discusses two forms of materiality. That which entails the carrier, where material is transformed into a technology that makes media processes possible, but also that which is "not media any longer".[32] With this latter category, Parikka addresses elements like the minerals that enter the technology in its creation, to the e-waste and residue products that are left behind in the production of the first category. It is this last category that provides a more theoretical reflection upon Starosielski and Walker's non-mediatic materialities.[33] In their description of this category, they even conclude the manual labour that goes into the production of the technology that, in the end, make media processes possible. As stated, this research follows this approach because it provides a more complete insight into the matter involved on both a practical level as well as from a theoretical standpoint. From a theoretical perspective, this allows for a reflection upon how this matter is accumulated, often in a destructive manner, and the way it is discarded after a reasonably brief period of time. As Cubitt argues, this relationship centres around accumulation, and a seeming lack of awareness of nature's limits.[34]

This realisation brings this research back to the original question posed, the balance between two forms of sustainability. Sustainable preservation as it is defined by the archives, with a focus on long term preservation and integrity of the collections, as well as environmental sustainability where resources are used responsibly. This research will practically analyse how this balance can be found but will also reflect upon this underlying issue of how we approach this materiality. What this concept brings is that we can acknowledge that by digitising our heritage, we are not immaterialising it. The materiality, in its finite essence, is still there. However now, it has become harder to see, and to engage with responsibly. This highlights the destructive relationship between us as humans, and the non-human.

To make this materiality visible again, this research specifically addresses the digital preservation process from a new materialist perspective. This overarching movement has been chosen, as it allows for room to acknowledge not only where the materiality is, but how we use this. Because in the end, this ethical debate outlined above, can be brought back to the relationship between the human and the non-human. A relationship where matter becomes something that can be used. What makes a new materialist perspective suitable, is because it not only recognises all forms of matter, but it also

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[30] Jussi Parikka, *The Anthrobscene* (Minneapolis: University of Minnesota Press, 2014).

[31] Parikka, *Anthrobscene,* 19.

[32] Parikka, *Anthrobscene,* 19.

[33] Starosielski and Walker, *Sustainable Media*, 13.

[34] Cubitt, *Finite Media,* 5.

includes the overall context and network in which it is accumulated, used, and thereafter discarded. As Parikka states: "So new materialism as media theory, in sum, can be seen as the intensive excavation of where (and when) actually is the materiality of media – and it should refuse preset answers".[35] This perspective provides the opportunity to zoom out, acknowledge all matter involved, as well as our relationship to it. It makes the materiality that has gone out of view, visible once again.

What this new materialist perspective specifically brings, is the concept of agency. Not only is materiality acknowledged from a full life-cycle approach, within new materialism non-human entities like all matter has an ability to act. As Iris van der Tuin and Rick Dolphijn have argued, this notion of non-human agency is tied to letting go of anthropocentric ideas.[36] This has been crucial to this research. This concept allows for room to acknowledge materiality on its own terms, as it were, without any other interests involved. It therefore denaturalises the idea of energy, minerals and all other matter that is involved in the research of preservation, as something we can use, and instead approaches it as a limited element within a larger process. It highlights materiality as an agent on which the process itself is dependent.

It must be stated that new materialism is an overarching movement of theories and concepts, and not one homogenic theory. This research specifically uses the definition and theory provided by Maria Tamboukou and her work on materiality within the archive. While her article "Archival research: unravelling space/time/matter entanglements and fragments" has been central, this research has also engaged with her online publication "New Materialisms in the archive: in the mode of an œuvre à faire".[37] In these works, Tamboukou bases herself on Karen Barad's description of "how matter matters" and argues that materiality within the archive is one actor in the entire network of actors.[38] Actors that "intra-act" according to Barad.[39] The difference between interaction and intra-action here, is that these actors all come into being together during intra-action, while interaction consists of already separate entities colliding. This research uses this distinction because it leaves from the notion of materiality in its entirety. What this practically means is that the minerals that are excavated from the earth are there, because of our need to create the technology that is at the basis of a medium. While at the same time, that medium can only exist because that matter does. There is not one position before the other, they come into being together.

As Tamboukou describes, this intra-action provides an opportunity to not only acknowledge this materiality and our relationship to it, but also how this intra-action forms the "conditions of

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[35] Jussi Parikka, "New Materialism as Media Theory: Medianatures and Dirty Matter," *Communication and Critical/Cultural Studies* 9, no. 1 (2012): 98.

[36] Rick Dolphijn and Iris van der Tuin, "Chapter 5: The Transversality of New Materialism," in *New Materialism: Interviews & Cartographies* (Open Humanities Press, 2012). 93-114.

[37] Maria Tamboukou, "Archival Research: Unravelling Space/Time/Matter Entanglements and Fragments," *Qualitative Research* 14, no. 5 (2014): 617–33; Maria Tamboukou, "New Materialisms in the archive: in the mode of an œuvre à faire", *Mai,* May 16, 2019.

[38] Tamboukou, "New Materialism," 2.

[39] Tamboukou, "New Materialism," 2.

possibility".[40] For Tamboukou's research, this means mapping how this intra-action between human and non-human actors in the archive results in the conditions of possibility for the production of knowledge. While this research will not engage with the production of knowledge to such an extent, it will use Tamboukou's description of the conditions of possibility to analyse how matter, in this case in the form of resources, stands in relation to the objects that are preserved, the archivists who design the process, but also all external agents that influence which heritage is preserved and how this is done. This new materialist perspective will ensure that materiality is not positioned in this research as something that can be used, as an automatic resource that can be accumulated, as Cubitt describes.[41] Instead, this perspective shows that the materiality involved in the preservation process has agency, and that it is inherently connected to the heritage collections and their future.

Together, these theoretical perspectives and concepts will provide the tools that are needed to execute a practical analysis of materiality involved in the digital preservation policy of the two archives, and to therefore reflect upon the environmental impact of these processes. At the same time, however, these tools will also allow for this research to transcend these findings and reflect upon the relationship between the human and the non-human. This will allow for an understanding how the paradigm shifts that Pendergrass et al. propose could be made a reality.

Main argument

The analysis of the preservation policies of both Sound and Vision as well as EYE will show that environmental considerations are currently not present in the preservation process of the two institutes. Through focussing on materiality, this research will locate where resources are used in an unsustainable manner, and how this results in environmental impact of the overall preservation process. It will conclude that the archives are currently executing many tasks and steps in this process to accomplish "sustainable" preservation, meaning the long-term preservation of the collections, while ensuring both integrity as accessibility of the material. This research argues that these goals have been shaped by the "human actors" involved in this process, like archivists, researchers, but also government and different financial funds. As these interests are now at the forefront of this preservation process, they shape all actions involved in the three categories of appraisal, permanence, and availability. Specifically, this research will describe how digitisation of the collections has made it possible to ensure these goals to an unprecedented extend. Now that materiality of storage and energy have become "invisible", archives are no longer confronted with the limits of using these resources in an unsustainable fashion. They are no longer limited by shelf space and therefore store more material than ever before, as it is no longer

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[40] Tamboukou, "New Materialism," 6-10.
[41] Cubitt, *Finite Media,* 5.

visible that a larger quality of storage also requires more material resources. For example, while 35 mm film storage obviously required more film than 16 mm, storing in 8k has no direct, visible consequences in comparison to storing film in 4k. The analysis will show that, in sight of all these possibilities, the material consequences of the preservation process are no longer considered. By focussing on the matter involved, this research is therefore able to locate where the environmental impact is present in this process.

Through the established theoretical framework, where this matter is approached as a non-human actor that intra-acts with the other actors in the archive, this research will be able to additionally provide a first orientation on how digital, audio-visual preservation can be approached in a more sustainable manner. As Pendergrass et al. already argue, a paradigm shift is necessary. This research argues that to accomplish this shift, a more non-anthropocentric perspective must be implemented in digital preservation practice. A perspective where material agency is acknowledged. Because only this will show that materiality is inherently tied to the preservation of the collections. What this analysis argues, is that sustainable preservation, and environmental sustainability are in the end, the same form of sustainability. Without material resources, the future of the collections cannot be guaranteed. If archives like EYE and Sound and Vision want to ensure the future of their collections, they must pay attention to the way that they accumulate and use material resources. While it can be argued that the public nature of these institutions should be motivation enough to incorporate a more environmentally sustainable practice, this research additionally highlights that this responsibility is inherently tied to their core task as archives. In practice, this does not mean that every decision should be based on environmental concern. Through the concept of intra-action, it will become clear that these two institutions have many other obligations but that these should be balanced with environmental concern by acknowledging both human and non-human agency in this process. This research argues that it should be a constant conversation between different interests, and while this will require applied evaluations in all different areas of preservation, this will need to come from an overall paradigm shift where the materiality of digital storage is acknowledged. This research will provide a first orientation of what this could look like. Because, if we want to preserve both our audio-visual heritage as well as our environment for future generations, there is just one form of sustainability.

Methodology

In order to answer the main question of this research, and thus understand in what way matter is involved in the process of digital, audio-visual heritage preservation, this research will first outline the ethical considerations between the two forms of sustainability. It will do so through an extensive literature review. Chapter one will engage with the materiality of the media industry through a focus on previous

research on the stages of production, distribution, and consumption. This will create an understanding of the materiality involved and serve as a steppingstone to review the work on digital audio-visual preservation so far. Together, this will create an understanding of how environmental impact can be understood in relation to the digital preservation process. Chapter two will also exist of a review of the literature and an elaboration of theory, but will serve to understand what audio-visual heritage is, why it is important to preserve, and provide a first orientation on how the preservation process can become more environmentally sustainable.

Having established this ethical debate between the importance of preserving audio-visual heritage, and its environmental impact, this research will be able to focus on practice through an extensive analysis of the preservation policies of both Sound and Vision as well as EYE. Chapter three will contain the results of this analysis. The information extracted from the policy documents, which can be found in Appendix I, has first been categorised under the three paradigm categories establishes by Pendergrass et al. This entails that all actions are subdivided under either 'Appraisal'. 'Permanence,' or 'Availability'.[42] Through this categorisation, an overview will be provided of all relevant actions, and the current decisions that both institutions make regarding these actions. A schematic overview of this information can be found in Appendix II. The gathered information will be analysed with the established theoretical framework in mind, to understand where materiality is present in these actions, where it has agency, and where it intra-acts with other actors in this process. This way, the materiality involved, and the potential environmental impact can be analysed from a non-anthropocentric perspective, where matter is understood as an equal actor in this process. This way, this research is able to, not only make statements on the current practices of the two institutions, but also on how environmental sustainability in these practices can be considered in the future.

This executed policy analysis has been supplemented with conversations with professionals working in the two archives. These conversations had the purpose to clarify any practices that were not clear in the policy documents, while also providing an additional understanding of the current awareness and willingness of the professionals in the industry to engage with the subject of environmental sustainability. While there is a risk of these professionals to attempt to present their work as more environmentally sustainable than it perhaps truly is, this is negated by the policy analysis. The formality of the information in the policy analysis can, in its own turn, be contextualised through the conversations. Together, this will provide the information that is needed to understand which considerations are currently made during this process, and how this can be approached in the future.

This method has been chosen because it will provide a first orientation on the current state of environmentally sustainable preservation in the two case studies. It must be stated that this method will not provide any quantitative overviews that analyse different practices on their energy consumption or Co2 emissions, for example. Nor will this research provide clear cut solutions that can be immediately

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[42] Pendergrass et al., "Sustainable" 180-196.

implemented in the field. What this research will argue is that this subject currently has not been given the attention that it needs, and that, to create sustainable change, a first orientation on current practices is needed. Through providing a Humanities perspective to this problem, this research attempts to present a clear understanding of the problem, while also presenting a first orientation on possible solutions. As stated, the archive is a place where disciplines meet, and this current issue is not any different. Both disciplinary as interdisciplinary further research will be needed before widescale policy changes can be implemented, but for this to be possible, the problem must first be addressed and understood. This research attempts to do just that, and to understand why practices are shaped the way they are, so that these processes can be rethought, and environmentally sustainable considerations can be made. That is what the chosen methods will accomplish.

Outline of thesis

Chapter 1: The matter with the media industry

The first chapter of this research is dedicated to understanding what it is exactly, when we talk about environmental impact. By answering this question, this chapter will create insight into the problem of environmentally unsustainable practice in the media industry. It will do so by turning to the concept of materiality. This chapter will first explain why a new materialist perspective is suitable for this research, as it offers the tools to analyse both materiality itself, but also its agency. Through a non-anthropocentric perspective, with a focus on the relationship between the human and the non-human, the materiality and environmental impact of the overall media industry will be discussed. Secondly, this chapter will engage with analyses of the production phase of the media industry, as well as the distribution and consumption phase, to understand what digitisation has changed and how materiality is still at the centre of these practices. This section will thereafter apply this knowledge on the impact of digital preservation specifically. It will specifically engage with Tadic's categorisation of the three primary areas of concern within the preservation of audio-visual heritage. [43] By additionally providing a focus on materiality in these three areas, this research will highlight the entire lifecycle of the material involved in the preservation process, and therefore truly reflect on the size as well as the cause of the problem, namely the relationship between the human and the non-human. The relationship that turns the material into a resource that can be accumulated and used.

Chapter 2: A sustainable approach to the archive

This chapter is directed at answering the question: What is digital, audio-visual heritage, and how can its preservation process become more environmentally sustainable? This section will first engage with

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[43] Tadic, "Environmental Impact".

the constructed notion of heritage, and its relation to the nation state. This section will also emphasize why preserving this heritage is so important, through a description of its role in the production of knowledge and the formation of identity. With the importance of heritage established, the second section of this chapter will be dedicated to a description of external organisations whose interests shape the preservation process as well. Lastly, this chapter will elaborate on the work by Pendergrass et al. to reflect upon how this process could become more environmentally sustainable.[44] Finally, this chapter will return to the established theoretical framework and elaborate how this understanding of heritage and the human actors involved, can be connected to New Materialist theory. Here, the concepts of intra-action and the "conditions of possibility" will be elaborated upon. In line with Tamboukou's description of these concepts, this will analyse the intertwinement between the human actors and material agency in the archive. [45] Lastly, this chapter will address the main argument of this research. This section will argue that the theoretical reflections on the relationship between the human and the non-human, as well as their agency, shows that there is just one form of sustainability. This understanding will create the possibility to return to practice and present solutions on how the suggested paradigm shifts within audio-visual archives could become a reality.

Chapter 3: Sustainability in Practice

The third chapter of this research will put the above argument into practice and present the results of the policy analysis of both EYE as well as Sound and Vision. Together with the results of the conversations with professionals of both archives, the information has been categorised according to Pendergrass et al.'s paradigm description. This data has thereafter been analysed with a focus on where material agency is present, and where the interests of other actors can be found. This has not only provided an overview of where environmental impact is located in the two preservation policies, but also where potential change could be made in the future. Most importantly, this chapter will conclude that environmental impact is indeed partly a consequence of the many obligations that the archives have, and the interests of the human actors involved. Together with the rapid succession of changes in the last decade due to digitisation practices, there has been little attention for the materiality that is still an active agent in this process. The findings of this research therefore hope to highlight the importance of not only acknowledging the materiality involved, but also the dependency of the collections on the material resources that keep them save and accessible. Exactly because it has agency over this process, the preservation process could not perform without its material resources. Environmental sustainability is therefore crucial if archives attempt to preserve their collections for future generations. Because in the end, there is just one form of sustainability.

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[44] Pendergrass et al., "Sustainable."
[45] Tamboukou, "New Materialism."

Chapter 1: The Matter with the Media Industry

The materiality of media

This research set out to understand how digital, audio-visual heritage preservation can become more environmentally sustainable. To do so, it must engage with both the environmental impact of the current practices in the preservation process, as well as with the materiality that is at the basis of this form of digital storage. This chapter specifically, will answer the question: What is the environmental impact of preserving digital, audio-visual heritage? The focus on materiality will contribute to this analysis in two ways. First, it will provide a tool to analyse what environmental impact is and how this can be located when analysing the preservation policy of an archive. Second, from a more theoretical perspective, it will provide the opportunity to engage with the underlying relationship between culture and materiality. What is the role of materiality in cultural practices such as heritage preservation, and what does this say about the underlying relationship between the human and the non-human? Through focussing on materiality, this research attempts to contribute to knowledge of both our interaction with our environment, and on a smaller scale, the materiality involved in the process of audio-visual heritage preservation in the digital age.

This chapter will provide insight into the environmental impact of audio-visual heritage preservation, through first elaborating on the concept of materiality, as well as the concept of agency. It will do so, from a new materialist perspective as this approach acknowledges the notion of non-human agency. This will create the possibility to lay the groundwork for a reflection on human and non-human agency within the audio-visual preservation process and achieve both a practical as well as theoretical analysis of this relationship. After a description of this framework, this chapter will engage with literature on environmental impact within the media industry. This review will engage with production, distribution and consumption of media and the materiality that is present in these phases. This will create an understanding of how digitisation has changed these practices, as well as how the issue of environmental impact has been approached by media scholars so far. This knowledge can thereafter be applied to elaborate on where the materiality of digital preservation can be found, and where it therefore potentially impacts the environment.

For this research, Parikka's work on materiality has been of great importance. In his chapter "So-called Nature", he addresses the question of what we see as media.[46] Especially now that most of the media we consume is produced, distributed, and consumed digitally, he wonders what this concept now entails. Are we only addressing the information transferred, or as Parikka questions, "do we see it

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[46] Jussi Parikka, "So-Called Nature: Friedrich Kittler and Ecological Media Materialism," *Sustainable Media,* ed. Nicole Starosielski and Janet Walker (London and New York: Routledge, 2016), 191-211.

as a question of material settings – media not just as a cultural reality of communication but at the same time, a material reality of technologies that, to put it bluntly, are made of *something* and demand *energy"*.[47] In the end, that is what this research is about. The matter that we use for our communication systems to function. It must be emphasized that materiality is not a synonym for unsustainable use. However, it is a starting point to analyse how we utilize this matter for cultural practices to see if they should perhaps be revised. As Parikka also explains, "materials have their aftereffects".[48] This is visible in the way energy is generated, but also in the way the minerals and raw materials that are present in the technology that we use, are excavated. Specifically, these effects are visible in the way this technology is discarded, as Parikka also highlights. He describes the e-waste that is left behind, in the form of discarded hardware, but also the toxic fluids and gasses that are leaked into the environment in producing the hardware.[49] This is an important description for this research because it elaborates on what is defined as materiality in this analysis. Specifically, this research will use the term "non-mediatic materiality" coined by Starosielski and Walker.[50] This term describes all this e-waste, but also includes the minerals that go into the hardware and even the labour that is involved in creating the hardware. It goes beyond the "infrastructures, technologies or objects" as the authors describe, and instead incorporates the entire lifecycle.[51] This will both create a more complete overview of the environmental impact, as well as account for how we uncover and dispose of materials, creating insight into how materiality is approached.[52]

Because as stated, this research attempts to go further than only identify where materiality is located in the preservation process. Instead, it wants to understand the relationship between culture and matter. To do so, this research will approach this relationship from a New Materialist perspective. While New Materialism is more of an umbrella term. The movement specifically focussed on what materiality as a concept can bring to theory. New Materialism acknowledged that mutual shaping happens in the interaction between human and non-human subjects, but that this dualism is perhaps not demarcated as previously assumed.[53] Rick Dolphijn and Iris van der Tuin describe New Materialist thinking as an overarching term for theory that rethinks oppositions.[54] All oppositions, as they write, "between nature and culture, matter and mind, the human and the inhuman".[55] What this practically means is that New Materialist theories centre around the notion that both the human as well as the non-human, shape each other, and that no clear binary oppositions between the two can be made. They all have agency, meaning they have the ability to act. While human actors have an ability to shape materiality, this relationship is

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[47] Parikka, "Nature", 196.
[48] Parikka, "Nature", 197.
[49] Parikka, "Nature", 204.
[50] Starosielski and Walker, "Introduction," 13.
[51] Starosielski and Walker, "Introduction," 13.
[52] For a more elaborate overview on materiality in media studies see: Tony Benett and Patrick Joyce, "Material Powers: Introduction," *Material Powers: Cultural Studies, History and the Material Turn* (London: Taylor & Francis Group, 2010); Serenella Lovino and Serpil Opperman, *Material Ecocriticism* (Bloomington: Indiana University Press, 2014).
[53] Dolphijn and van der Tuin, "Chapter 5," 93-114.
[54] Dolphijn and van der Tuin, "Chapter 5," 93.
[55] Dolphijn and van der Tuin, "Chapter 5," 93.

just as much formed by material agency. Additionally, New Materialist theories do not assume that one of these actors is a stable entity. Emilie Moberg writes how, when New Materialist theories are used as a methodology, they do not assume there is a stable researcher in the network that they form with its material objects, for example. Both object and researcher are already intertwined and come into being together within the process of research.[56]

As Niğmet Çetiner describes in her summarizing chapter on New Materialisms:

"The New Materialisms is a theory that has its origins in theoretical physics. Its aim is to create awareness about the entanglements of humans and the more-than-human world so that humans will act more cautiously towards the environment and will likely include ontology and ethics in their process of scientific knowledge production."[57]

Through discussing these relationships between the human and the non-human, a New Materialist perspective can therefore additionally create awareness of the importance of environmentally sustainable practice. For this reason, a New Materialist approach has been taken on in this research. Attention to materiality in this way will not only highlight where it is present but will recognise its agency and the overall relationship between these actors. Most important for this research, is that this approach steps away from an anthropocentric perspective and approaches materiality on its own terms. As Dolphijn and van der Tuin also write, New Materialist theories, due to their embedding within feminist theory, deal with issues of power.[58] By letting go of an anthropocentric perspective, and instead acknowledge the agency of materiality, this matter's power also becomes visible. This is especially relevant due to the invisible matter involved in digital storage that was previously addressed. This research attempts to make this matter visible again, while gaining insight into how this is approached within the archive. Or in different words, it will be able to help this research reflect upon the goal of analysing the relationship between culture and materiality.

A New Materialist perspective is specifically relevant for this line of thought, due to its connection to Haraway's term "NatureCultures". As Dolphijn and van der Tuin describe, the matter was often overlooked due to the anthropocentric hierarchy in these dualisms, placing the human and its culture above the non-human, or nature. Within New Materialism, however, this matter is emancipated. And as they argue, it is therefore possible to stir the debates and traditions that have been dominant in the humanities for so long.[59] When assuming that these binary distinctions are not there, and that all these actors are intertwined, New Materialist thinkers do not see nature and culture apart.[60] The term

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[56] Emilie Moberg, "Enacting affirmative critique: exploring the conjunctions and overlaps among Actor-network theory and Feminist New Materialist methodologies," *Reconceptualizing Educational Research Methodology* 9, no. 1 (2018): 32.
[57] Niğmet Çetiner, "A recent trend in The Humanities: The new materialisms as philosophy and theory," in *Theory and Research in Social, Human and Administrative Sciences II,* ed. Erdem Sarikaya (Ankara: Gece Kitaplığı, 2020): 229.
[58] Dolphijn and van der Tuin, "Chapter 5," 93.
[59] Dolphijn and van der Tuin, "Chapter 5," 94.
[60] Dolphijn and van der Tuin, "Chapter 5," 90-94

NatureCultures it suiting, because Haraway argues that both are "socially formed" and the human realm and its social structures can therefore not be seen apart from the ecology and environments that they are present in, they are intertwined and inseparable.[61] Following this line of though back to the media industry, and specifically digital preservation, it provides a perspective to focus on this intertwinement, instead of seeing the archive and its material resources as two separate realms. Or stated more practically, our communication is inseparable from the plastic, metal, and glass that we use to communicate with.

This perspective will therefore provide the connection between our cultural practices, and their ecological footprint. As Parikka writes in his chapter on New Materialism as Media Theory: "So new materialism as media theory, in sum, can be seen as the intensive excavation of where (and *when*) actuality is the materiality of media – and it should refuse preset answers."[62] It is therefore a theory that will highlight how materiality goes further than just the hardware in our hands, or the storage devices that fill our data centres. Because, as Parikka continues: "Indeed, materiality is not just machines – nor is it just solids, and things, or even objects. Materiality leaks in many directions – also concretely (e-waste).[63] When we take this perspective, other aspects are highlighted, like the minerals that go into the hardware, the toxicants that leak out of it when we dispose of the objects, and the CO_2 that goes into the atmosphere when we use fossil fuels to power our storage centres. Through highlighting this matter, a new materialist perspective will contribute to this research on a practical level. Secondly, this approach will contribute to the theoretical reflections this research attempts to make, reflections on the relationship between culture and materiality, between the human and the non-human. New materialism shows that materiality has agency, in the sense that is has an ability to act. Cultural practices may shape this matter into a resource it can use, but this matter just as much shapes our cultural practices. However, as Parikka also states, this is not always in a positive way. A New Materialist perspective will highlight the 'dirty matter' involved in our media processes as well.[64] The matter that contaminates and pollutes our environment. In this research, it is exactly that matter that is of vital importance as this results in inevitable environmental impact. Together, this will provide a perspective that can recognise and detangle the web of human and non-human agents that are present in digital, audio-visual preservation policies.

With this knowledge, and from this point of view, the following section will analyse the actual impact of the media industry by discussing different phases, from production to distribution. It is notoriously difficult to work with exact numbers of environmental impact because of the incredible number of factors that play into these numbers and a lack of accessibility of this data, and this will therefore be outside of the scope of this research. However, by acknowledging and discussing the matter

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[61] Dolphijn and van der Tuin, "Chapter 5," 93-96
[62] Parikka, "New Materialism," 98.
[63] Parikka," New Materialism", 98.
[64] Parikka," New Materialism", 98-99.

involved in these processes, this research will be able to analyse the most important factors and phases of the industry that influence the environment, and therefore give an overview of the relationship between the media industry and its resources.

The environmental impact of the media industry

Having established this notion of materiality and its agency, the following section will engage with literature on environmental impact, and specifically the materiality of the overall media industry. Because the preservation of audio-visual objects is only the last stage, preceded by production, distribution, and consumption of those objects. As research on the environmental impact of digital preservation is still in its early stages, engagement with these other phases will provide insight into how materiality is approached by companies within the industry, as well as how scholars have engaged with this issue. In this industry, in line with human conduct in all other parts of consumer culture, materiality is approached as something that can be used. As Cubitt describes, in the introduction to his book *Finite Media,* "accumulation has become an end in itself" only followed by the redistribution of that material in different forms to accumulate more wealth.[65] This research uses this term, accumulation, because this materiality is not just 'used'. As this section will show, the way the industry is engaging with this matter is characterised by a sense of excess and waste, that goes beyond simply using what is needed. The media industry is, above anything else, a business with the aim to make profit. In this process, matter, in the form of minerals, raw materials or energy, is only treated as a resource, and approached as if it is infinite. We are using, processing, and throwing away the materials around us until we can no longer even recognise their materiality for what it is. Especially now that our communication has become predominantly digital, we are not confronted with its materiality in the same way as before and are therefore also not faced with our responsibility to handle this with care. Once again in line with societies' overall approach towards the world we live in, we see our environment as exactly that, ours to use.

However, it cannot be denied any longer that this approach has catastrophic consequences. For years, wide-spread scientific research has warned that this approach to the materials around us, may it be the use of fossil fuels, immense deforestation or the unimaginably amounts of plastic in the oceans, is unsustainable. Besides the direct damage done to the ecosystems in which most organisms need to survive, our current use of energy causes our earth to warm up faster than ever before. While action has been taken, it seems too not be enough. For the *Paris Agreement,* 196 countries agreed in 2015 to

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[65] Cubitt, *Finite Media,* 5.

decrease their greenhouse gas emissions to limit global warming to 1.5 degrees Celsius.[66] However, in 2020, this maximum temperature was already reached in most parts of the northern hemisphere. As Tadic mentions in her presentation on the Environmental Impact of Digital Preservation that she gave at multiple conferences over the years, the current estimate is that by 2100, the earth's temperature will have risen by even 3 degrees.[67] While extremely worryingly by itself, a 2022 report by the *World Health Organisation* together with the *United Nations Environment Programme*, stated that even when limited to 1,5 degrees, global warming will have disastrous consequences in the form of extinctions of ecosystems, water and food scarcity, increase in the number and intensity of natural disasters and damage to the overall health and well-being of humans.[68]

This era, where we can see the direct consequences of our behaviour on the earth we inhabit, has been labelled the Anthropocene. A geological age in which humanity has directly impacted both its environment and the overall climate.[69] While the concept crosses disciplines and its implementation and precise definition therefore also vary, Paul Crutzen and Eugene Stoermer, who originally coined the term, determined the industrial revolution as the start of the Anthropocene.[70] While the industry surrounding communication and media technology is obviously just one part of this larger problem, the term highlights the damaging relationship with materiality that is at the basis of these objects. Parikka goes even a step further, coining the term the "Anthrobscene".[71] He states: "In short, the addition of the obscene is self-explanatory when one starts to consider the unsustainable, politically dubious, and ethically suspicious practices that maintain technological culture and its corporate networks."[72] His geological perspective is a way to both acknowledge and analyse the materials that are taken from the earth and used in the machines and technology that underlie the media industry, and therefore also the industry's relationship with that material. They cannot be seen apart.

The Anthropocene extends over a much longer period, but the digital revolution that we are currently inhabiting has brought its own specific challenges. While media's history has always intertwined with that of our earth, the digital nature of our current media ecology has created a myth of immateriality. No more than 20 years ago, our VHS tapes were exchanged for DVDs, while many people will currently have neither in their home anymore. Digital streaming has replaced these physical copies, and therefore limited our confrontation with the materiality that carried the content we consume. As Nadia Bozak describes: "Going digital is more than ever considered a default means of "going green" and is generally taken for granted as having sustainability built in."[73] The lack of physical media

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[66] "The Paris Agreement," United Nations Climate Change," accessed March 30, 2022, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement; "Opwarming noordelijk halfrond heeft de 1.5 graad bereikt," KNMI, November 30, 2021, https://www.knmi.nl/over-het-knmi/nieuws/opwarming-noordelijk-halfrond-heeft-de-1-5-graad-bereikt.

[67] Tadic, "Environmental Impact.

[68] "Climate Change 2022: Impacts, Adaption and Vulnerability," Intergovernmental Panel on Climate Change, World Health Organisation and the United Nations Environment Programme (2022): 15.

[69] Yadvinder Malhi, "The Concept of the Anthropocene," *Annual Review of Environment and Resources* 42 (2017): 77-104.

[70] Paul Crutzen and Eugene Stoermer, "The Anthroposcene," *Global Change Newsletter* 41 (2000).

[71] Jussi Parikka, *The Anthrobscene,* Minneapolis: University of Minnesota Press (2015).

[72] Parikka, *The Anthrobscene,* 10.

[73] Nadia Bozak, *The Cinematic Footprint* (New Brunswick, New Jersey and London: Rutgers University Press, 2012): 12.

owned by consumers, can give the idea that there are less resources going into the content that they are watching. However, as Richard Maxwell and Toby Miller write, behind all technology there are practices that create environmental destruction and promote unsustainable and unfair labour.[74]

While these practices are invisible to most consumers, the domain of media scholars also remains primarily focussed on the representational abilities of media. Or, as Kääpä argues, the 'brainprint' of media, instead of its 'footprint'.[75] Even though the focus on materiality has become more prominent in the last couple of decades, the study of the materiality of digital storage is still in its early stages. The following section will look at the media industry and its footprint, with specific attention to the materiality involved. In this case, this section will be limited to film, but similar life cycles could be drawn up for other media, who all have different but similarly harmful relations with the matter involved. While this description will only be able to grasp the surface, this will still highlight patterns of waste and access and provide insight into the skewed relationship between media and its materiality.

Production

The production phase of all media, but especially film, has been widely researched by media scholars. This is partly due to the size of the industry, as well as the financial scale of modern-day film productions. In the last two decades, it has become a norm for large blockbuster productions to have a budget starting around two hundred or even three hundred million dollars.[76] These finances only give a glimpse into the resource dependence of the film industry. While money does not always equal resources, this budget does give insight into the scale of these projects, and as Vaughan shows, they will therefore have a considerable environmental footprint. Vaughan has researched the destructive nature of these films. He describes how the blockbuster arrived while film transformed from a "cultural novelty of attractions to a massive, institutionalized industry".[77] In his book, he argues that the blockbuster specifically, centres around destruction. "A destruction of the real at the service of symbolic pleasure".[78] These productions require an excess of resources, both in their required technological hardware, as in the worlds they build up, and thereafter destroy, either on screen or after production ends. Productions of this size rely on sizeable sets (which are often immediately broken down after use), the transportation of large crews, as well as many single-use items like clothing, make-up, and props.

Additionally, film production includes a long, technology reliant process of post-production where, depending on the film, energy consuming techniques like Computer Generated Imagery (CGI)

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[74] Maxwell and Miller, *Greening,* 9.
[75] Kääpä, *Environmental Management,* 2-3.
[76] Michele Debczak, "The 10 Most Expensive Movies Ever Made," *Mental Floss,* April 22, 2021, https://www.mentalfloss.com/article/645745/most-expensive-movies-ever-made.
[77] Vaughan, "Hollywood," 38.
[78] Vaughan, "Hollywood," 37.

are used. These techniques require hardware, which has its own material life cycle, but also a lot of energy. CGI filled blockbusters, however, are not an exception. Vaughan discusses the production of the classic film *Singin' in the Rain*.[79] Here, he analyses how the representation of water in the film only draws attention away from its excess use of resources during production. As he states, "On every level, the film hinges on the triumph of humanity over nature, the crafted excess of the Hollywood spectacle".[80] This argument specifically, highlights how film's representational abilities are often in painful contrast to their actual production. As Kääpä argues, the media industry has been praised and analysed for its ability to communicate environmental issues, its brainprinting abilities.[81] However, this brings up the question if the productions therefore not have a responsibility to also engage more with their footprint if these makers want to communicate an environmental message. This same would be the case for all phases of the media industry. The "wider socio-environmental or physical-material impact" of our media, as Kääpä argues, would therefore require more attention.[82]

Distribution and consumption

The production stage of media is not the only phase of a media object that is intertwined with its material resources. For the consumer, the distribution of both film and television has perhaps changed the most over the years, as the analogue carriers were replaced with digital streaming. Because consumers no longer have a physical collection of their DVD's or VHS tapes, they are not confronted with the materiality of these media objects to the extend they were before. Streaming would therefore appear to be the more sustainable option. Even in the academic debate, it has often been repeated that streaming a film would indeed produce less Co2 than watching a DVD. However, as Laura Marks argues, this statement is mostly based on a 2014 publication that in its turn was based on data from 2011.[83] Since then, consumption habits have increased drastically. Additionally, the quality in which we stream our content has become a lot higher, and therefore counters the reduced CO2 and use of resources. However, scholars do not always agree on this issue. Aditya Nair, Gregory Auerbach, and Steven Skerlos disagree with the notion that these would outweigh each other.[84] Their findings state that even with calculation of the increased viewing habits, streaming was still used 49% percent less energy than DVD viewing of films. They also concluded these findings by placing additional responsibility with the consumer, stating that contrast and lighting settings on television sets should be adjusted to be more energy

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[79] Vaughan, "Hollywood," 59-90.
[80] Hunter Vaughan, "500,000 Kilowatts of Stardust: An Ecomaterialist Reframing of *Singin' in the Rain,"* in *Sustainable Media,* ed. Nicole Starosielski and Janet Walker (London and New York: Routledge, 2016), 23-37.
[81] Kääpä, *Environmental Management,* 2-3.
[82] Kääpä, *Environmental Management,* 2.
[83] Arman Shebabi, Ben Walker and Eric Masanet, "The energy and greenhouse-gas implications of internet video streaming in the United-States," *Environmental Research Letters* 9, no. 5 (2014).
[84] Aditya Nair, Gregory Auerbach, and Steven J. Skerlos, "Environmental Impacts of Shifting from Movie Disc Media to Movie Streaming: Case Study and Sensitivity Analysis," *Procedia CIRP* 80 (2019): 393–98.

friendly.

When looking at these findings, it turned out that their research has predominantly focussed on energy use and did not account for other forms of environmental impact. They therefore did not acknowledge the full materiality of digital streaming, as they did not analyse the non-mediatic materialities, like the raw materials within the hardware, the e-waste left behind after this hardware is discarded or even the toxins that are released in the production and destruction of these objects. Additionally, as Marks also states, it seems naïve to place responsibility with the consumer.[85] In her article, she discusses different strategies to minimize the footprint of streamed media content. Besides the use of renewable energy and by making the data centres that store our media more efficient, her predominant argument states that we need to reduce demand, in the sense of unlimited, on-demand and high-quality media. In opposition to Nair et al, she points out that users do not automatically 'demand' higher-quality or faster media if this is not offered. When constantly providing an even higher quality or faster service, people will also choose this option. Instead, low-impact media can be made attractive, she argues. Placing the responsibility with the consumer, who has little influences on policy and development of these billion-dollar industries, should not be the primary focus if we want to reduce environmental impact. Instead, we should be looking at the market dominating production companies and streaming services who provide the content, to take responsibility for their environmental footprint. Only then, true policy changes can be implemented.

Afterlife

In sum, research like that of Nair et al. does not acknowledge the full lifecycle of the hardware used, or the non-mediatic materialities involved in these production and distribution practices. As already stated, this is important because it gives insight into the full scale of the problem, as well as into our relationship with this matter that is characterised by accumulation. However, this research wants to specifically highlight the afterlife of the technology used in the media industry, because of the urgency of this problem. This technology includes both the hardware with which productions are recorded and edited, but also with which it is stored, distributed, and consumed. While there is awareness in the debate of the rapid obsolescence of consumer hardware, in the form of phones and televisions that are constantly replaced for newer models, this focus does not always extent to the hardware involved in the production, storage and distribution of media.[86] As Maxwell and Miller describe, this hardware is "turned into junk overnight."[87] It is this junk that must go somewhere and becomes e-waste. As Tadic summarizes, e-

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[85] Marks, "Carbon," 50.
[86] For an example of this awareness, see: Sigrid Kannengießer, "Engaging with and Reflecting on the Materiality of Digital Media Technologies: Repair and Fair Production," *New Media & Society* 22, no. 1 (2020):123–139.
[87] Maxwell and Miller, *Greening,* 2.

waste can consist of everything from computers, cables, batteries, data storage devices, monitors and much more, as there are only four "end-of-life" options for these objects. They can either go to a landfill, they can be incinerated, they can be recycled, or they can be exported.[88] When considering this overall life cycle of a media object, Parikka argues that the "new" in new materialism is related to this dismissive use of minerals. He writes how they were buried deep into the earth for millions of years, only to be excavated by humans to use them for 3-5 years after which they are discarded, and while now being toxic and harmful, they return to the earth.[89]

Important to discuss more in-depth is the exportation that Tadic mentions. The disposal of e-waste is, just like mineral mining, production labour and environmental consequences not equally distributed globally. As Maxwell and Miller write: "E-waste has mostly been produced in the Global North (Australasia, Western Europe, Japan and the United States) and dumped in the Global South (Latin America, Africa, Eastern Europe, Southern and Southeast Asia and China) in the form of thousand different, often lethal materials for each electrical and electronic gadget […]."[90] For years, the extraction of these minerals, mostly lithium, has been outsourced to countries in the Global South with both environmental as well as direct health concerns.[91] The same goes for the increasing amount of toxic e-wate that is transported to the Global South once hardware has been replaced due to rapid obsolescence. These materials contain toxins like "lead mercury, cadmium, arsenic and flame retardants" that eventually leak into the environment if not properly dismantled.[92] However, with a lack of proper infrastructure to dismantle and recycle them correctly, local communities suffer the price. Additionally, it has become clear that the most economic vulnerable countries will suffer first and most from climate change. While these countries often have considerably smaller footprint than the largest polluters like Western Europe and North America, they will be confronted with the first consequences due to failing harvests, raising sea-levels and an overall increase in natural disasters.[93] While only one part of a larger problem, the current policies in the media industry that are characterised by excess and waste, are directly attributing to this.

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[88] Tadic, "Environmental Impact," slide 32.

[89] Parikka, "New Materialism," 98-99.

[90] Maxwell and Miller, *Greening,* 3.

[91] Thea Riofrancos, "Shifting mining from the global south misses the point of climate justice," TBS News, February 08, 2022, https://www.tbsnews.net/analysis/shifting-mining-global-south-misses-point-climate-justice-368176; This research is aware of the controversial nature of the terms Global South and Global North, as these are to ambiguous terms for many specific countries, areas, cultures and economic systems. Unfortunately, a more suiting term in this case has not been identified and this research has therefore chosen to follow Maxwell and Miller's terminology.

[92] John Vidal, "Toxic E-Waste Dumped in Poor Nations, Says United Nations," Our World, December 16, 2013. https://ourworld.unu.edu/en/toxic-e-waste-dumped-in-poor-nations-says-united-nations.

[93] Roger McKenzie, "In the Global South, Climate Change Already Kills," Tribune Magazine, November 03, 2021, https://tribunemag.co.uk/2021/11/climate-change-global-south-asia-africa-heatwave-cyclone-natural-disasters-cop26-glasgow.

The environmental impact of digital, audio-visual preservation

The life cycle of a media object as sketched above, shows that the matter in our media objects is not going anywhere if it stops being that object. In different forms, it remains within the ground and our waters. However, what about the content or communication that it carried? Some of this audio-visual material is preserved within institutions, both for later re-use, to exhibit and to archive this for later generations. As Tadic mentions, it is hard to determine exact numbers of how much audio-visual heritage is stored globally, as this happens in cultural heritage organisations (CHO's) like "libraries, archives and museums", but also in corporate organisations and in private consumer collections.[94] Additionally, it can be argued that audio-visual heritage is also preserved by social media platforms like, *YouTube*. Alan Mckee has described the popular site as a democratic archive, in which users upload their own audio-visual material to be stored as well as to interact with.[95] While these social media platforms, have their own environmental footprint, the focus here will remain on cultural heritage organisations. These organisations often have the most extensive infrastructure that is specifically built with the goal to preserve the material for the future (in opposition to corporate companies like *Google,* who owns *YouTube,* and which is an advertisement company. CHO's are often specified to a specific medium and have multiple functions and long-term goals. At least in the Netherlands, these institutions have the primary goal of persevering audio-visual material for the future, both for scholars as well as the public, but at the same time they preserve this material for re-use within the media industry.[96] Additionally, these institutions often invest a lot of time and resources for educational purposes, like increasing media literacy in the next generation or providing material and research tools for students in higher education.

While this research focusses specifically on digital preservation of these collections, it is important to address the complications with the preservation of analogue carriers as well, as this was one of the prime motivations for digitising collections. For the first half of the 20th century, the industry standard carrier was that of cellulose nitrate. However, this mode of preservation required very precise temperatures as the material deteriorated when its environment reached temperatures higher than 21 degrees Celsius or when stored at a humidity higher than 50%.[97] Worryingly enough on its own, it turned out that the gases that are created during this decay are highly flammable, causing serious health concerns. For this reason, Dutch archives like EYE and Sound and Vision, now store their older nitrate

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[94] Tadic, "Environmental Impact," slide 32.

[95] Alan McKee, "YouTube versus the National Film and Sound Archive: Which Is the More Useful Resource for Historians of Australian Television," *Television and New Media* 12, no. 2 (2011):154-173.

[96] Nederlands Instituut voor Beeld en Geluid, *Digitale Preservering Beeld En Geluid: Beleid, Standaarden En Procedures* (2016); Stichting EYE Filmmuseum, *Collection Policy 2018-2021* (2018).

[97] "Nitrate Films," American Museum of Natural History, last accessed July 22, 2022, https://www.amnh.org/research/natural-science-collections-conservation/general-conservation/health-safety/nitrate-films.

collections in climate-controlled bunkers in the Dunes in North Holland.[98] This nitrate carrier was thereafter replaced by a safer standard, namely acetate film. However, this too had its challenges as it turned out that this was prone to something called Vinegar syndrome, a contagious threat to the material that destroys the film (and has a dominant vinegar smell, hence the name). This syndrome can be prevented, but also needs special ventilation and temperature control to do so.[99]

For these reasons, as well as to increase accessibility of the material, much of the heritage in these institutions is now digitised, or in the process of becoming digital.[100] Together with the material that comes into the collection digitally (so called digital-born material), these collections are growing exponentially. These projects, like Images for the Future, state how these digital files are stored 'sustainably' and how this will ensure the preservation of these collections in the future".[101] The specific nuance here, lies in the Dutch translation of the word 'sustainable'. 'Duurzaam' can indeed mean, the preservation of something for the future. However, at the same time, its meaning is often referred to responsible use of resources in a way that is not damaging to the environment, so called environmental sustainability.[102] How compatible are these two forms of sustainability? Is sustainable preservation also environmentally sustainable?

While not a lot has been written about environmental sustainability in this phase of the media industry, the before mentioned presentation by Tadic on the subject has been particularly enlightening. In this presentation, she summarizes the many different forms of digital storage. As already stated, digital preservation is a physical occurrence, not only through its use of water and energy, but most obvious in its reliance on physical hardware. Tadic summarizes the three most used types of physical carrier that are often combined, namely the "Spinning Disk (servers and hard drives), digital tape and NAND (Flash memory or SSD memory)."[103] She elaborates on each carrier's characteristic and specific downside. For example, while hard drives need a lot of energy, external drives can be used as offline storage as well, but still need to be replaced every 3 to 5 years. In opposition, tape storage requires less energy and has a life expectancy of 30 years. But as Tadic mentions, it is a standard to replace them every two generations. Another possibility is storing within 'the cloud', which would entail storing the data on other people's servers. This latter option, however, would often not be a possibility for archives, as this would mean storing their collections on commercial servers. Additionally, from an environmental perspective, it would be difficult to gain insight into the forms of energy that are used by the companies who host the cloud.

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[98] "Nitraatfilm," Beeld en Geluid, last accessed July 22, 2022, https://wiki.beeldengeluid.nl/index.php/Nitraatfilm; "Depots in Overveen, Heemskerk en Castricum," EYE, last accessed July 22, 2022, https://www.eyefilm.nl/nl/nitraatfilms/649194.
[99] EYE, Collection Policy, 17.
[100] For more information, see: "Beelden voor de Toekomst," Beeld en Geluid, last accessed July 22, 2022, https://www.beeldengeluid.nl/kennis/projecten/beelden-voor-de-toekomst.
[101] Van Excel et al., Beelden van het Verleden, 8-28-31-58.
[102] "Taalontwikkeling in beeld: duurzaamheid door de eeuwen heen," Van Dale, December 14, 2016, https://www.vandale.nl/taalontwikkeling-in-beeld#:~:text=In%20de%20vijfde%20editie%20van,betekent%20'kan%20lang%20mee'.
[103] Tadic, "Environmental Impact," slide 51.

In her presentation, she summarizes how audio-visual preservation impact the environment in three ways. Firstly, through the destruction of the analogue carriers once they have been digitised. Secondly, through the use of energy for powering and cooling hardware, and the resulting greenhouse gas emissions. Lastly, through the destruction of hardware carriers after they have been replaced, resulting in e-waste.[104] When looking at the hardware, Tadic elaborates on the minerals that go into these objects and states that "less than one percent of rare earth mineral are currently recycled."[105] They end up in landfills where they seep back into the environment through the groundwater, and where they become an actual threat to both human and non-human life. However, what Tadic does not mention, are the non-mediatic materialities of this hardware, in the form of the minerals and raw materials that are often harvested in unsustainable and even inhumane ways. As a report by the International Labour organisation shows, much of the minerals that are part of the "global supply chain" are mind by children, among which some work under "conditions of forced labour."[106] When these rare earth minerals are eventually mined, they are often already discarded after a few years, when the new generation is released, and the hardware has become obsolete. To refer back to Parikka, they were in the earth for millions of years, only to be discarded after 3-5 years.

The materiality involved with these prominent levels of energy consumption should also not be discarded. The preservation of audio-visual material entails the use of a lot of energy through both powering the hardware as well as cooling it. As The Netherlands energy supply is only 11,1% renewable, it can therefore be stated that this energy use will mostly be dependent on fossil fuels and therefore produce the emission of greenhouse gasses, most of it CO_2.[107] The energy in the preservation process, is necessary to digitise analogue material, or to make sure the digital-born material is stored according to the procedures in place. Additionally, this energy goes to the hardware that accesses the collections and presents them to the user. All this energy is rooted in materiality, its most destructive consequence being CO_2 emission.[108] Tadic estimates that the amount of data that is stored by CHO's globally is around the 29.2 Exabytes (meaning a trillion bytes) which is still a low estimate as this only has one extra copy of the material calculated in, while the industry standard is two.[109] While this is a rough estimate for the amount of energy that is used to store all this material, as it is dependent on many factors like quality, hardware and format, it does give a glimpse into the amount of resources that are involved in digital preservation practices. Additionally, it is often not the storage that is the biggest consumer of energy, but the accessibility, as these actions often require an additional copy as well as constantly powered-on hardware. As stated, it is exactly this accessibility that is a primary motivation

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[104] Tadic, "Environmental Impact," slide 10.
[105] Tadic, "Environmental Impact," slide 39.
[106] "Child Labour in Mining and Global Supply Chains," Child Labour Platform, May 2019, https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-manila/documents/publication/wcms_720743.pdf.
[107] Maria José Linders et al., "Hernieuwbare Energie in Nederland 2020," CBS, September 30, 2021, https://www.cbs.nl/nl-nl/longread/aanvullende-statistische-diensten/2021/hernieuwbare-energie-in-nederland-2020?onepage=true#c--2--Algemene-overzichten.
[108] Tadic, "Environmental Impact," slide 13.
[109] Tadic, "Environmental Impact," slide 8.

for digitising analogue collections.

However, as stated, it is not as simple as storing the object on the hardware. When the material enters the collection, either digitised or digital-born, it requires a vastly different treatment from analogue material. As an employee of EYE described, while analogue film as a medium is very cost- and energy-intensive to create, it can thereafter lay on a shelf for decades (if the right humidity and temperature are maintained) without any need for care. Digital material is the exact opposite. While it is reasonably labour and cost efficient to create, it requires a lot of maintenance. The dominant storage type in The Netherlands is the LTO tape, and similar to video tape, these carriers are very prone to decay. While the tapes would, in theory, last 30 years, it is an industry standard to replace the hardware every 5-7 years to prevent any damage, after which the original tape becomes redundant.[110] The object stored is then migrated to a newer model LTO tape.

Additionally, each migration requires fixity checks, to ensure that the material stored is unchanged. These checks verify if the object remained the same on bit-level. In case none of these prevention methods work, there is at least one, and more often two, copies of the material stored somewhere else to ensure the preservation of the material.[111] All these actions require a lot of energy, as technology needs to be powered on and cooled. All these factors will be discussed more in-depth in chapter three, but this summary shows how resource intensive the digitalisation process is. Acknowledging the materiality that is embedded in each step of this process highlights the importance of analysing how these practices are intertwined with finite resources. The quantity that can be stored on the tapes will only increase each year, and there is an urgency to reflect upon the consequences of also using all this digital space.

Important to keep in mind is that the process of digital-born storage and the digitalisation of analogue audio-visual heritage is a fairly new process. Most archives have only been working with these digital storage possibilities for less than two decades. As they are still learning how to constantly adapt to the newest changes and technological possibilities. the institutions themselves as well as the academic debate seem to not be fully engaged with the issue of environmental impact of digital heritage, as they are still working on fully grasping the possibilities to begin with. Tadic is one of the few scholars who has practically engaged with this issue. Other publications, however, like that of Julie McIntyre or James Faulkner, Lixing Lu and Jiangpin Chen present attention to the issue, but do not go any further than awareness. McIntyre, for example, mentions that we should be aware of the limitations to storage space, while addressing the myth of digital space as unlimited. [112] Faulkner et al. have done quantitative research about the environmental consciousness within archival policy through counting and analysing

[110] Tadic, "Environmental Impact," slide 5-7.
[111] Tadic, "Environmental Impact," slide 89.
[112] Julie McIntyre, "Blank Pages, Brief Notes and Ethical Double-Binds: Micro Digitisation and the "Infinite Archive," *Archives and Manuscripts* 44, no. 1 (2016): 2–13.

if important factors are mentioned in archival strategies.[113] However, these publications remain limited to an analysis of the awareness of the issue, but do not yet engage with the many factors involved with the problem or the possibility for any environmentally sustainable solutions.

To conclude, this chapter has provided insight into the environmental impact of persevering audio-visual heritage through an engagement with new materialist theory as well as literature on the materiality of the overall media industry. On a practical level, this chapter has been able to lay down the groundwork for where environmental impact can be identified in archival policies, and why it is important to analyse materiality when doing so. This includes accounting for the complete lifecycle of hardware, and therefore including non-mediatic materialities as well. On a more theoretical level, this chapter has reflected upon the relationship between cultural practices, like digital, audio-visual preservation and materiality. It has explained why a New Materialist perspective will create the possibility to reflect upon the underlying relationship between the human and the non-human. This will provide the opportunity to also approach possible solutions to environmental impact, by acknowledging all actors, human and non-human, which come together in the process of digital preservation.

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[113] James Faulkner, Liuxing Lu, and Jiangping Chen, "Archivists' Golden Egg: Environmental Sustainability Practices of Archives," *The Electronic Library* 39, no. 2 (2021): 258–80.

Chapter 2: Discovering sustainable preservation of audio-visual heritage

The formation of heritage

Having established the environmental impact of digital, audio-visual heritage preservation, this chapter will engage with possible environmentally sustainable solutions. However, to do so, it is important to first understand what these collections are and why they are being preserved in the first place. This chapter will therefore address the question: What is audio-visual heritage, and how can its preservation process become more environmentally sustainable? It will answer this question by engaging with literature on the construction of heritage and its, now debated, relation to the nation state. This will create an understanding why these collections are preserved. This research will build on this understanding by addressing the notion of the archive as an institution and discussing the surrounding organisations that influence how archives shape their preservation processes. This will show how archives have several obligations that must be accounted for if this research wants to understand how the preservation process can become more environmentally sustainable. The work by Pendergrass et al. will be central in this orientation on sustainable preservation, as their research has provided the groundwork to not only address specific actions in the preservation process, but to review the overall paradigm under which this process is developed.[114] Lastly, this chapter will return to the New Materialist framework that has been established in chapter one. Through elaborating on the concept of agency through Tamboukou's work on intra-action, this section will be able to develop its reflection on the relationship between the human interests in the archive and the materiality involved.[115] Therefore, this will also provide a further theoretical reflection on human and non-human relationships.

As Caroline Frick writes in her introduction to the book *Saving Cinema: The Politics of Preservation,* the concept of heritage is not a static given. Instead, it is a socially constructed and intertwined with notions of community and knowledge production.[116] To understand this, it is important to first look at its origin and historical development. Frick describes how, up until the 19th century, heritage usually referred to personal heritage within families, past down from generation to generation. However, as she describes, with the "proliferation of nation-states in the 1800s, the private familial arena of heritage became associated with the general civic or societal values and communal property of the nation"[117] The rise of nationalism in the decades after emphasised this idea of the national heritage, only aggravated by the reconstruction that took place after the Second World War.[118] Rebuilding a

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[114] Pendergrass et al., "Sustainable."
[115] Tamboukou, "Archival Research."
[116] Frick, *Preservation*, 6.
[117] Frick, *Preservation,* 14.
[118] Frick, *Preservation,* 5-6.

country required repairs, but it also involved the protection of what, by then, had been established as a country's "cultural and material assists".[119] This was soon legally reinforced by the UNESCO convention, focussed on the "Protection of Cultural Property in the Event of Armed Conflict" in 1954.[120]

Media heritage specifically, has been connected to the concept of the nation state. The moving image was deployed for its potential to reinforce 'imagined communities', a term coined by Benedict Anderson to describe how individuals can identify as part of a socially constructed group without there being direct signifiers to distinguish them from others.[121] The moving image has the potential to connect people with each other, and emotionally connect them to the nation. The preservation of these object has therefore historically been a national matter as well. As Chiara de Cesari and Ann Rigney argue, cultural remembrance, has the agency to reconfigure these imagined communities.[122] They can reinforce the sense of a shared past, and the idea that the nation itself has always been a given. However, the notion that heritage is inherently national has been heavily debated. Both media as well as the eventual heritage collections are not bound to national borders. Films and television are inter- and transnationally produced and often distributed in many countries. Digitisation of these processes has only made this international nature more profound, as information can travel to the other side of the world in seconds.[123] However, while its national nature is under discussion, this historic connection between media heritage and the nation state is important to keep in mind when analysing how preservation processes are shaped. Because this connection leads to an idea of national ownership of these audio-visual collections, also often resulting in the public nature of archives.

Besides this formation of imagined communities, audio-visual heritage collections are also important sources for knowledge production. Today, digital, audio-visual heritage is categorised under the general label of cultural heritage. This latter category is protected by UNESCO, or the United Nations Educational, Scientific and Cultural Organization. They define cultural heritage as the following:

> "Cultural heritage includes artefacts, monuments, a group of buildings and sites, museums that have a diversity of values including symbolic, historic, artistic, aesthetic, ethnological or anthropological, scientific and social significance."[124]

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[119] Frick, *Preservation,* 14.
[120] Frick, *Preservation,* 14-15.
[121] Anderson, *Imagined Communities.*
[122] De Cesari and Rigney, "Introduction."
[123] This debate on inter- and transnational media history unfortunately lies outside of the scope of this research. For further reading, see: Judith Keilbach, "The Eichmann Trial on East German Television: On (not) reporting about a transnational media event," *VIEW: Journal of European Television History & Culture* 03, no. 5 (2014): 17-22; Golo Föllmer and Alexander Badenoch, eds. *Transnationalizing Radio Research: New approaches to an old medium* (Bielefeld: Transcript Verlag, 2018); Tim Bergfelder, "National Transnational or supranational cinema? Rethinking European film studies," *Media, Culture & Society* 27, no.3 (2005): 315-331.
[124] "Cultural Heritage," Glossary, UNESCO, last accessed July 27, 2022, http://uis.unesco.org/en/glossary-term/cultural-heritage.

UNESCO also addresses the importance of audio-visual archives specifically, as they not only hold collective memories but can produce knowledge through their reflection of the "cultural, social and linguistic diversity of our communities. They help us grow and comprehend the world we share".[125]

De Leeuw describes how audio-visual heritage "contains both record and a representation of the past" and how this can reflects history on multiple levels. [126] Through its technological object, through its content but also through how it represents the world from a certain point of view and in a specific context that can teach us a lot about (media) history. De Leeuw continues: "Theoretically online television programme sources are objects that function as mediators between past and present, between history and memory, but also between the self and the past as represented in the online archive."[127] While she speaks predominantly about television, the same can be said about film. Film heritage too, can serve as a mediator between our past and present.

This process of knowledge production through audio-visual heritage collections thus happens on multiple levels. First, they reflect the medium itself, and can provide a canon of programmes or films that reflect developments in the medium as well as possible artistic movements where it was implemented. Film heritage, for example, can provide insight into how the medium was used in broader artistic movements, or how it adapted to converge with other media. Having these films preserved provides the opportunity to reflect on the characteristics of the medium and its development over time. Secondly, audio-visual archives and their collections can provide insight into the technological developments of the media carriers over time. This produced knowledge on the technology itself, in the form of film, tape, or digital streaming, while simultaneously could therefore also be combined with how this material carrier shaped the content that they held. Thirdly, these objects, both in the way they reflected society as well as how they were used can produce knowledge about the role of media in society, historically as well as today. Television, for example, was long a centrepiece within many households and was characterised by a sense of liveness but has evolved to include more on-demand and individualistic characteristics. While this description is in not exhaustive, these examples show how important these collections are to produce knowledge in multiple and how they can be of service to scholars.

This potential of audio-visual heritage as a source of knowledge does also extend to environmental issues. It is the potential that Kääpä called 'brainprinting', the ability to create awareness and stimulate change through media's representational characteristics.[128] What this practically means is that media objects, may they be film or television, have the potential to reflect environmental concerns, and educate people on more sustainable practices. This is also what collections in the archive can do,

[125] "World Day for Audiovisual Heritage," UNESCO, last accessed July 27, 2022, https://en.unesco.org/commemorations/worldaudiovisualday.
[126] De Leeuw, "Television," 12.
[127] De Leeuw, "Television," 15.
[128] Kääpä, *Environmental Management,* 2-5.

as the work by authors like Jennifer Lynn Peterson shows. In her chapter called "Cinema, Nature and Endangerment," Peterson projects our modern understanding of environmental impact, or "endangerment sensibility" as she calls it, on historic nature films.[129] Through her analysis of several films from this genre, she argues that they have two forms of potential. They can create a form of "nostalgia" for a time where nature appeared to be untouched by mankind. Secondly, they have a potential for "sparking environmental awareness through a process of revitalization and remediation by digital media".[130] The previously addressed work by Vaughan also falls into this category, as his eco-critical analyses of historic films shows how this preserved media can be analysed with modern day perspectives to highlight the underlying relationship between culture and the environment.*[131]*

The work by both Peterson as well as Vaughan shows how preserved media can be of worth to the environmental debate. Historic audio-visual objects play a crucial role in understanding our current hyper-mediated world and the development of technologies, as well as how this relates to our environment and earth's limited resources. However, as this research also argues, while preservation of these objects is of value to create an understanding of our relationship to our environment, this worth does not authorise unsustainable preservation practices. This research argues that the opposite is true. Especially because of media heritage's abilities for 'brainprinting', to use Kääpä's terminology, it is important to also be concerned with their 'footprint'.[132] What this means, is that archives should not only engage with their ability to represent heritage but also support this representation of our endangered environment through sustainable action.

Defining the archive and its obligations

Having established what audio-visual heritage is, and why it is worth preserving, it is important to look further into the definition of the institute that holds this heritage, the archive, and its obligations. Because these institutions rarely stand on their own, and many other organisations, with their own interests, are involved in deciding if, what and how audio-visual heritage is preserved. Frick describes how the archive generally differs from a museum or a library, as archives are ""repositories for the material produced or generated through the course of business by organisations such as a government entity, a corporation, or an individual."[133] This means that they are often responsible for the preservation of certain public broadcasters, or government funded projects in the form of film organisations and funds. However, as more institutions are labelling themselves as archives, the term has become more

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[129] Jennifer Lynn Peterson, "Cinema, Nature, and Endangerment," in *Ends of Cinema,* ed. Richard Grusin and Jocelyn Szczepaniak-Gillece (Minneapolis, Minnesota: University of Minnesota Press, 2020), 53–78.
[130] Peterson," Cinema," 54.
[131] Vaughan," Stardust."
[132] Kääpä, *Environmental Management,* 2-5.
[133] Frick, *Preservation,* 12.

diluted and is now often connected to issues that have to do with "cultural value, protection, ownership and power – power emboldened and sanctioned by the archive's emphasis upon *preservation*".[134] As this research will show, it is important to analyse how an institution labels itself, as it provides insight into its motivations as well as its core tasks and values. It will provide an opportunity to analyse the possibilities as well as the restrictions for the two institutions to incorporate more sustainable preservation practices.

With the historic connection between heritage and the nation state in mind, it is clear why many institutions are deemed "public". Archives are often either government "repositories" or receive government funding. How this relationship takes place in practice is related to the medium that the archive preserves. Steve Bryant describes how television heritage for example, is mostly preserved by national television archives, as these institutions are related to public service broadcasters.[135] He explains that connections like this relate back to the fact that television was not deemed worth archiving for a long time, resulting in public service broadcasters to develop their own archives.[136] Because of this relationship, their function as official repository is often described by law, emphasizing the public nature of these television archives. While film archives do not always have this official legal responsibility, they are still obligated to perform certain tasks because of the funding they receive. Frick too, describes that the possibilities and restrictions of an archive are frequently dependent on the amount of funding they receive.[137] These external organisations all have their own interests that, through this financial dependency, can influence if, what and how archives preserve their collections.

Besides these legal and financial obligations, it is important to emphasize that archives are also expected to follow international guidelines and regulations. International organisations produce regulatory standards of preservation that covers most actions, from which formats or hardware to use, to how authenticity of the collections should be safeguarded. They provide guidelines and standards that ultimately work to the goal of ensuring collections for the future. While not mandatory, these standards carry a form of legitimacy and are therefore often followed. Often, these organisations are medium specific, like The International Federation of Television Archives (IFTA) for broadcasting archives and the International Federation of Film Archives (FIAF) for film. Both these organisations offer a place to share knowledge, organise conferences and even create financing for archives in need. These initiatives are important, as they share knowledge and therefore further develop the practice of heritage preservation. The standards set by these organisations, however, also inform the decisions made in the preservation process of archives and should therefore be considered in this research. Analysing the goals and values of all these external organisations or government entities that are connected to the archive can highlight their interests and help to better understand why the preservation

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[134] Frick, *Preservation,* 12.
[135] Steve Bryant, "National Television Archives and Their Role," *Critical Studies in Television: The International Journal of Television Studies* 5, no. 2 (2010): 63.
[136] Bryant, "National," 60.
[137] Frick, *Preservation,* 25.

process of a certain institution is structured the way it is. This accountability can be divided in two main tasks. First, archives are obliged to preserve their collections for the future as they are repositories and receive funding to perform this task. This includes preventing decay of analogue carriers as well as ensuring the integrity of the digitised objects. Secondly, again because they are repositories, but also because of their public nature, archives are often obliged to keep these collections accessible for the public. Additionally, initiatives like IFTA and FIAT influence the specific ways that these tasks should be carried out.

These obligations directly motivate initiatives like Images for the Future. As stated, the primary incentives of this project were to preserve the collections for future generations, as well as make this media heritage more accessible and searchable.[138] Two goals that could be achieved by digitising the collections. Digitisation is a way to transfer decaying, analogue material into a digital file and therefore preserve this for the future. Additionally, digital files are more accessible for both the public and professionals. Local proximity to the archive itself is not a requirement anymore if one wants to view the item and once it is digitised, it can easily be re-used by industry professionals in other film or television recordings.[139] As Pierlugi Ercole et al. argue in their article on European cinematic heritage: "The safeguarding, preservation and valorisation of the cultural heritage has increasingly become associated with the process of making cultural heritage assets available online".[140] However, while digitisation would seem to be the perfect solution to fulfil the archives' obligations, it has become clear that this is not without consequences. Digitisation has completely changed the preservation process.

First, digitisation has changed *what* audio-visual archives preserve. Previous analogue collections where severely limited through the available shelf space. Analogue film or videotapes take up a lot more space in comparison to digital storage, and archives therefore had to critically select what they would and would not include in their collections. Digital storage on LTO-tapes, for example, does not only use up a lot less space, but the available storage space on the tapes will only increase in the future. As technology is developing, the amount that can be stored on the tape will grow exponentially which each new model of the carrier. This is also described by authors like Julie McIntyre and Ian Milligan who have used the term 'infinite archive'.[141] While they relate this term to micro-scale digitisation and specific web-archives, it is important to acknowledge that in the age of the prosumer, where the user/consumer becomes the producer through the possibilities that the internet offers, a lot

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[138] Beeld en Geluid, "Beelden voor de Toekomst".

[139] It is important to acknowledge that authorship is also an important factor in this network surrounding the preserved objects. Especially in relation to digital accessibility, archives are also required to navigate the complicated legal area of copyright restrictions. Especially when preserving modern or recently published objects, curators and the archive need to balance their public function that aims for as much accessible material as possible with their legal restrictions in protection of the authors intellectual property and possible re-use.

[140] Pierluigi Ercole, Daniela Treveri Gennari, Silvia Dibeltulo and Lies van de Vijver, "Cinema heritage in Europe: Preservering and sharing culture by engaging with film exhibition and audiences," *Alphaville: Journal of Film and Screen Media* 11 (2016): 1.

[141] Julie McIntyre, "Blank Pages," 2; Ian Milligan, "Lost in the Infinite Archive: The Promise and Pitfalls of Web Archives," *International Journal of Humanities and Arts Computing* 10, no. 1 (2016): 78-94.

more media will be suitable for preservation.[142] Besides the incorporation of these newer forms of media, the number of regular film and television objects that can be preserved will also grow exponentially. Not only are there a lot more television channels, but the number of film productions in the Netherlands has also increased. Together, it can be stated that a lot more media objects are available for preservation today, and that this number will only increase. Together with the exponential growth of available digital storage space, the idea of the infinite archive, or at least one with continuously expanding boundaries, is not as far-fetched as it would appear.

With this expected growth, it is important to gain more insight, and create an awareness of the materiality of this storage and the resources involved in the entire preservation process. Because increased storage, and especially increased accessibility costs energy, both through powering the hardware as well as cooling it. Additionally, the data on the hardware must be migrated every few years, which entails transferring the data on a newer model carrier, after which the hardware is discarded. This has a considerable environmental footprint and actively contributes to the global e-waste problem. However, it could also be stated that replacing this hardware is environmentally beneficial, as the new versions are often more efficient, and therefore use less energy. Newer models also hold more storage, using less minerals and raw materials to store the same amount of data. However, this increased efficiency of the newer hardware in comparison to older models is counteracted through what is called the 'Jevon's Paradox'. This paradox explains how increased efficiency of hardware or certain processes, will also lead to increased use of that hardware of process, nullifying the ecological profit that was created in the first place.[143] This example shows how digitisation of the archive has brought completely new challenges that have to be researched first, to be handled responsibly.

Because secondly, digitisation has dramatically changed *how* audio-visual heritage is preserved. As previously described, digitisation requires a lot more actions to ensure the preservation of the object, and specifically the integrity of the object, in comparison to analogue storage. The archive must constantly be able to present that the object preserved is unchanged, and that its integrity remains intact. Through the previously mentioned fixity checks, and constant migration, every activity surrounding a specific object in the collection is recorded. With this transparency, an archive can protect its authority as a repository. Due to their overall preservation of the collections, as well as their accessibility, the archive can be labelled as 'sustainable'. However, what the description of digital preservation practices has hopefully shown so far, is that this does not equal environmental sustainability. This results in a very delicate, and almost ethical balance between two forms of sustainability. Can we digitally preserve the collections for the future, while also protection the environment? This research argues that if this balance is to be found, there is first a pressing need for a more realistic acknowledgement of the materiality beneath digital storage.

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[142] Many audio-visual archives, like Sound and Vision, are already including web videos into their collection.
[143] Pendergrass et al., "Sustainable," 172.

How can digital, audio-visual preservation be more environmentally sustainable?

So far, this chapter has established the importance of audio-visual heritage, as well as the many external organisations surrounding the archive. This has shown that the archive does not stand on its own in the design of the digital preservation process. Instead, multiple other interests, obligations and standards influence this process. Digitalisation of audio-visual heritage may seem like a way to fulfil these obligations and outside interests, but as this research has established so far, digital storage is still surrounded by a myth of immateriality and unlimited space. This results in environmental impact directly linked to the preservation of audio-visual heritage. An impact that presents an ethical dilemma when faced with the established importance of these collection. Not only is audio-visual heritage a great source of historic knowledge but it can also provide insight into mankind's relationship with its environment. Together, it is a question of how these two forms of sustainability can go together. How can we preserve audio-visual heritage in an environmentally friendly way? The following section will engage with this question. After reviewing some practices that are standard in the media industry, and a discussion of why they would not be appropriate for implementation in the archive, an in-depth description of the work by Pendergrass et al. will be given to engage with possible solutions to the environmental impact of audio-visual heritage preservation.

Perhaps one of the most used sustainability practices is that of carbon-neutral film production, as was introduced with films like Al Gore's *An Inconvenient Truth* and the 2004 blockbuster *The Day After Tomorrow,* both films that centred around global warming and environmental impact.[144] As Bozak writes about this latter film, director Roland Emmerlich did not want to contribute to global warming with the production of this climate conscious film, and engaged with a "carbon offsets provider". What this practically entailed was that the production paid "229.000 dollars to offset the 10,000 tons of Co2 emissions".[145] This money would thereafter be used to "plant trees and invest in climate-friendly technology".[146] While this technique sounds like a proper solution, it also received a lot of criticism as, it is hard to determine if these initiatives truly compensate for the Co2 emissions produced. As Bozak also argues, it is a form of buying of the environmental guilt without truly engaging with the problem. She writes:

> "Primary critiques include the difficulty in monitoring and regulating such intangible deliverables, while programs themselves merely allow industry and individuals […] to absolve themselves of guilt or fulfil obligatory quotas instead of actually changing those detrimental practices directly responsible for resource depletion and environmental

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[144] *Day After Tomorrow,* directed by Roland Emmerich, (20th Century Studios, 2004), 02:04:00, DVD; *An Inconvenient Truth,* directed by Davis Guggenheim (Participant Media, 2006), 01:36:00, DVD.
[145] Bozak, *The Cinematic Footprint,* 6.
[146] Bozak, *The Cinematic Footprint,* 6.

degradation".[147]

In the case of *The Day After Tomorrow,* carbon-neutral production functions as a way to highlight its environmental message, without actually engaging with the problem itself. This is also the reason this would not be a solution of digital preservation. Not only would this require finances that most archives will not have, but it would also not be a true solution to the problem, as it does not deal with the cause.

When brainstorming for sustainable solutions, this research has also looked at sustainability within digital storage by technology companies like *Google* and *Meta*, as this practice is closely related to what digital storage in the archive. For these companies' platforms to run, incredible amounts of data must be stored, for which data centres like the one discussed in Zeewolde, are required. All this hardware that makes storage and access to this data possible, requires energy and needs to be cooled in order to run. As articles by both Alix Johnson and Anne Pasek show, is that the location of these data centres is important. Johnson discusses how Iceland has become a popular location for data centres and argues that this placement is intertwined with what he calls "imaginaries".[148] Iceland's imagery is centred around low temperatures and untampered nature, which is combined with the countries' use of 99% renewable energy and cold climate. This imagery presents the country therefore as a perfect location for data centres. Through using this image for marketing purposes, the idea of "green" storage is created. In reality, the cooling of these data centres is not done by "raw Icelandic air" but by "specialized proprietary technology".[149] Pasek too, analyses the management and rhetoric used in the location of data centres. She discusses how rhetoric is now often directed to sea areas, as she states: "It may also amount to a new form of fungible exchange: trading atmospheric and terrestrial disruptions for aquatic ones".[150] What these authors show is that discourse is important when discussing environmental management in the media industry, something Kääpä agrees with. He argues for the "specificity and significance of political and cultural context of the industry when it comes to ecological sustainability".[151] In practice, he elaborates, this means that sustainable options are still often seen as an obligation, rather than a necessity.[152] Through legislation focussed on specific local and cultural contexts, this could change. These examples show that many solutions are related to the idea of being sustainable, without truly engaging with the issue. This research argues that this is because these solutions do not address the materiality involved in these processes. Environmental impact cannot be simply shipped away, marketed, or bought off. Instead, the problem must be faced, and materiality must be recognised.

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[147] Bozak, *The Cinematic Footprint,* 6.
[148] Alix Johnson, "Emplacing Data Within Imperial Histories: Making Iceland's Information's 'Natural' Home," *Culture Machine* 17 (2019): 1-12.
[149] Johnson, "Emplacing Data," 7.
[150] Anne Pasek, "Managing Carbon and Data Flows: Fungible Forms of Mediation in the Cloud," *Culture Machine* 16 (2019): 1-15.
[151] Kääpä, *Environmental Management,* 189.
[152] Kääpä, *Environmental Management,* 194.

One of the key works on sustainable, digital preservation is the article by Keith Pendergrass et al. called "Toward Environmentally Sustainable Digital Preservation."[153] In the article, the authors discuss the impact of what they call the ICT involved in preservation. Similar to this research, the authors follow the life cycle of the hardware in order to account, not only for its energy use, but also for "raw material extraction and refining, shipping at multiple points, manufacture, electricity and cooling during use, and, finally, disposal".[154] As they state, only focussing on the materials that go into the hardware on which the data is stored, already highlights a "significant negative environmental impact, before even a single component is powered up". [155]

Regarding solutions, the authors first discuss multiple short term, technological solutions that can reduce the environmental impact of their preservation processes. First, these institutions can make the way they use their energy more sufficient.[156] This can be done in many ways, but one approach is to make efficiency of the chosen hardware top priority, and placing it over the hardware's performance, when deciding on specific devices. Additionally, what the authors call "standard efficiency practices" can be followed, which entail turning devices off when not in use or placing more devices in a stand-by mode.[157] These organisations can also go one step further and rethink the actual design of the storage and make this more efficient by only powering certain parts while not leaving others on standby. Another short-term solution has to do with scheduling. Pendergrass et al. argue that CHO's should "schedule high-energy and high-bandwidth tasks for off-peak times."[158] This means that it is not only prevents contributing to the peak in energy use in the area, but most importantly that it avoids the need for different infrastructure. This infrastructure would be needed if they would contribute to high peak times, as basic local energy supply would not be able to cope. By not contributing to high peak times, where the local area is already using the most energy, this can be prevented. This would mean scheduling more practices that can be planned, like migration of data for example, to night times or during "seasonal off-peak" periods, and not during very warm or very cold periods. The third short-term solution Pendergrass et al. present is perhaps the most clear-cut, the use of clean energy sources. They state that this too can be approached in diverse ways, like solar panels on site or the use of renewable energy certificates. However, in this latter case, the authors argue, it is important to ensure that the electricity is coming from "regional electricity grids".[159]

While promising, Pendergrass et al. emphasise that these re just short-term, "interim" solutions. They argue that they are simply interim solutions that will not, in the end, solve the problem of unsustainable practices in the preservation industry. Instead, they argue for "digital preservation

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[153] Pendergrass et al., "Sustainable."
[154] Pendergrass et al., "Sustainable" 174.
[155] Pendergrass et al., "Sustainable" 174.
[156] Pendergrass et al., "Sustainable," 177-179.
[157] Pendergrass et al., "Sustainable," 178.
[158] Pendergrass et al., "Sustainable," 179-180.
[159] Pendergrass et al., "Sustainable," 180.

paradigm shifts".[160] Now, success is measured based "total storage size or file count" meaning the amount of material preserved, and the "implementation of preservation risk reduction strategies".[161] More is better, it would seem, and the goal is to not lose a single thing that is meant to be preserved. Pendergrass et al. state that, if the industry genuinely wants to become more environmentally sustainable, it will be these goals and the work within these paradigms that needs to be adjusted. The norms of preservation, and the ultimate goals where these institutions are working towards, cannot be taken at face value anymore and should instead be revised. Pendergrass et al. argue:

> "We propose that creating environmentally sustainable digital preservation requires a paradigm shift in appraisal, permanence and availability of digital content. Only by revaluating 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, can the profession create sustainable digital preservation."[162]

The author have thus identified three areas in which paradigm shifts are required. These will be further elaborated upon in the next chapter, but these shifts can be summarised as the following. First, the appraisal of content.[163] With this the authors mean the decisions made on what to preserve for the future and what not. As the authors also state, this is often an "resource intensive" practice due to many file formats and hardware involved, and the diversity in treatment that every item requires. Pendergrass et al. therefore argue that appraisal must be selective when it comes to digital content, and that only "content with enduring value is permanently retained."[164] Within this, they specifically state that the appraisal process must be specified to digital preservation specifically, and that in these considerations, the environmental impact of the ICT processes should be considered as well.

A second paradigm shift the authors propose is directed to the notion of permanence within the preservation process.[165] This truly applies to the heart of archiving, as this questions the idea of permanence in the preservation process of archival material, something considered one of the core tasks of archives. However, what the authors propose is a revision of the many practices that ensure this permanence of an object, and specifically the question of integrity of the material. This means revising the zero acceptance of possible changes to the object that is now an international standard among archives. Instead, compromises should be found, and a balance must be created between preserving the

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[160] Pendergrass et al., "Sustainable," 180-181.
[161] Pendergrass et al., "Sustainable," 181.
[162] Pendergrass et al., "Sustainable," 181.
[163] Pendergrass et al., "Sustainable," 182-184.
[164] Pendergrass et al., "Sustainable," 182.
[165] Pendergrass et al., "Sustainable," 184-191.

collections' integrity as much as possible without implementing too many resources intensive actions.[166]

The third paradigm shift relates to the availability of the objects.[167] As already discussed, access is the other part of the coin of preservation and steers many decisions that are made within the preservation process. As Pendergrass et al. describe, modern users expect the same level of availability of archived objects as they do on the internet, meaning an on-demand and near-constant availability. Striving for this form of accessibility requires not only mass-scale digitisation, but also the development of infrastructures that are always powered-on and therefore use a lot of energy. Instead, Pendergrass et al. argue, this "mass-digitization" should be reconsidered and instead of on-demand all time availability, archives should strive to "timely- but not necessarily immediate- delivery".[168] This means that, while acknowledging that accessibility of the material is one of the key tasks of any archival institution, the way this is delivered can be re-assessed.

Together, these three areas in which the paradigms of digital preservation can be rethought to create room for environmental sustainability. These shifts go further than direct solutions, as they inherently question the assumed values and core tasks of archives. However, while these values may have long been established, this does not mean that they are unchangeable, especially when one considers Frick's argument that preservation and heritage are, in the end, socially constructed practices. As she argues:

> "Viewing preservation as discourse or as structured practice, rather than as the neutral, logical way of incorporating historical moving images into contemporary life, scholars and practitioners can observe how film heritage has been constructed and invoked at particular times, for specific reasons, and by particular individuals."[169]

It is important to once again state that the value of the heritage is not in question here. However, the practices that are incorporated to preserve this material are. This research argues this inherent worth of the original, untouched object is socially constructed and that this can therefore also evolve into a paradigm that acknowledges and respectfully approaches the resources and environmental impact involved in these processes. This does not mean the worth of the preserved objects is deemed any less, but that the materiality that lies underneath this preservation is considered and valued as well, to make fully informed decisions during the archival process.

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[166] Pendergrass et al., "Sustainable," 181.
[167] Pendergrass et al., "Sustainable," 191-195.
[168] Pendergrass et al., "Sustainable," 192.
[169] Frick, *Preservation,* 13.

Intra-action in the archive

So far, this chapter has established why audio-visual heritage is worth preserving, but also how the archive works as an institution. This has highlighted the many obligations that the archive has through its connection with external organisations, obligations that also shape how the final preservation process is designed. Additionally, New Materialism has provided a perspective that acknowledges both materiality as well as its agency. While acknowledging materiality created the possibility to identify environmental impact, the concept of agency allowed this research to look further at the relationship between this materiality and the cultural practices within the archive. However, what this New Materialist framework also brings is that these external organisations can be identified as actors in the archive as well. While matter is established as a non-human agent, this research argues that related government or funding organisations, just as the curators in the archive, are human agents in this process. These actors all have certain interests and are all intertwined with non-human agents in the archive.

As this research is specifically interested in these intertwinements within the archive, the relationship between the human and the non-human, the work by Tamboukou has been of significant importance. In her article "Archival research: unravelling space/time/matter entanglements and fragments", she reflects upon what she calls "entanglements" between human and non-human agents in the archive.[170] Tamboukou specifically uses a New Materialist perspective to highlight the relationship between the materiality of the archive, and knowledge production. She leaves from the idea that knowledge is partly produced through the decisions made by the archivist, but also argues that the materiality of the archive itself is entangled with this production. While this research does not engage with knowledge production, it will follow Tamboukou's definition of human and non-human agency in the archive because of her perspective on the entanglement between the two. Specifically, her description of how these agents "intra-act".[171]

The concept of intra-action was first introduced by Karen Barad as she placed it in opposition to "interaction".[172] As Tamboukou summarises their work:

> "While interactions occur between already-established and separate entities, 'intra-actions' occur as relations between components. Entities – both human and non-human – actually emerge as an effect of these intra-actions, without having stable points or positions".[173]

Tamboukou deploys this concept to describe how matter intra-acts with human agents, and how the

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[170] Tamboukou, "Archival research."
[171] Tamboukou, "Archival research," 621-625.
[172] Tamboukou, "Archival research," 621
[173] Tamboukou, "Archival research," 621.

knowledge that is produced in the archive is eventually a result of this entanglement. This research argues that this intra-action between human and non-human agents also happens on the level of the preservation process. They come together in the archive, and neither of these actors is a pre-established entity beforehand. Instead, as Tamboukou also writes, the agents' "particular constitution can only hold within the conditions of the research process".[174] Or, in the case of this research, how both material as well as human agency are formed because of their entanglement in the archive. The concept of intra-action helps this research to reflect upon these entanglements because it goes further than a causal relationship. As Tamboukou writes, agency of matter does not refer to a cause-and-effect event, because for that the agents must already be fully formed.

For this research, this causality would mean that matter would already enter the archive fully formed, that it would be a resource ready to use. But as this research has established so far, this is not the case. Minerals and raw materials are not in the earth for us to use, and neither are they ready to be used. They are excavated, shaped, and applied in a way that serves our cultural practices. At the same time, the preservation of cultural heritage is only possible through the existence of this matter and must adapt to the possibilities that this matter has. There are limits to how it can be used. A more causal relationship would therefore not explain this entanglement between the human and the non-human. Analysing this process with a causal relationship in mind would hold on to the anthropocentric focus this research explicitly attempts to let go, and simply see matter as something we can use. Instead, intra-action as a concept helps to see both the human and the non-human on their own terms. When we let go of this anthropocentric focus, and the idea of matter as something we can use, this relationship can be analysed more clearly. It acknowledges that the human and the non-human shape each other. Or to state it more practically, the matter and the cultural practices shape each other, and both determine how the final preservation process looks like.

This entanglement is described by Tamboukou as the "conditions of possibility". She writes: "In the absence of separability among the components of the phenomena, intra-actions between them become agentic forces through which the components become determinate within the conditions of the phenomenon they are part of".[175] This shows exactly why this perspective is so valuable in analysing the role of environmental concern in the design of the preservation process of digital, audio-visual heritage. The way energy or raw materials are used is determined by how the preservation process is shaped, which itself is formed by other leading actors like government, policy makers or local infrastructure. Energy as a resource itself, however, also determines what is possible and influences how preservation infrastructure is designed. They cannot be separated because they all intra-act to form the "conditions of possibility".

Thus, this chapter has set out to provide insight into the construction of what is called heritage. It has explained how the archive is a place where many different agents, both human and non-human

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[174] Tamboukou, "Archival research," 621-625.
[175] Tamboukou "Archival research," 623.

are entangled. Tamboukou's specific description or archival intra-action shows how these actors, from government institutions to curators to the objects themselves and the materiality that makes this storage possible, all come into being together. They are shaped in relation to each other in a non-causal line of influence. What this research has also shown is that digitisation has changed these practices rapidly and that archives are still attempting to fully grasp the possibilities, as well as the requirements that digital storage brings forth. Specifically, because the archive as an institute has many obligations, the most important being the preservation of the objects as well as the accessibility of these collections. The decisions to digitise many audio-visual collections alone shows that these motivations also come into being through legal obligations and international standards. It would be naive to expect archives to simply incorporate more sustainable practices, without acknowledging that they must function in very specific frameworks and fulfil many external obligations as well. What this research argues, however, is that because of these changes and obligations, there is little room left for environmental concern. This is the case because the materiality of digital space is not recognised enough. This acknowledgement is therefore needed, to responsibly preserve the collections without damaging the environment. Archives must engage with their dependency on materiality and recognize how irresponsible use will therefore lead to unsustainable preservation as well.

At the same time, this research set out to take this analysis one step further and reflect on the relationship between the human and the non-human. This perspective shows that this relationship is still too anthropocentrically focussed, as material is automatically seen as a resource. This matters because labelling something as a resource implies its existence is there to serve our needs. As if the minerals buried in the earth are there for us to use and assimilate into technology so we can communicate with each other. Through a New Materialist perspective, this research has been able to go beyond analysing where matter is located but also analyse where we intra-act with it in our cultural practices. Besides this reflection, which teaches us more about this relationship, this insight is also of use in a more applied search for sustainable, digital preservation. As Pendergrass et al. argue, there is a need for complete paradigm shifts, as single interim solutions are not enough.[176] This research argues that for these shifts to happen, materiality must not only be acknowledged, but its agency and intra-action with other actors should be considered as well. Only this way, it becomes clear that environmental sustainability and sustainable preservation are the same thing. The archive is dependent on this intra-action, and on the overall matter that makes this storage and accessibility possible. If they want to continue to preserve these collections in the future, a more environmentally sustainable approach should be implemented.

To conclude, the main argument of this research is threefold. Firstly, as the analysis in the following chapter will emphasize as well, environmental concerns are currently not part of the considerations made during the preservation of digital, audio-visual heritage. As work by Pendergrass et al. shows, we need more than temporary solutions, but need to implement paradigm shifts to truly

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[176] Pendergrass et al., "Sustainable," 184-191.

make the heritage preservation industry more environmentally sustainable. Secondly, this research argues that these paradigm shifts can be realised by analysing the relationship between the human and the non-human, between culture and matter. Through implementing the concept of intra-action, this relationship can be approached from a non-anthropocentric perspective that shows that culture and matter do not only influence each other, but that they come into being together through their entanglement in the archive. Thirdly, this research argues that this perspective and the recognition of the environmental impact of current processes, will result in the acknowledgement that there is just one form of sustainability. Sustainable preservation, meaning preserving the heritage for future generations, and environmental sustainability during the preservation process, are in sum the same goal. Heritage is inherently material, and this matter should therefore be handled responsibly. Once this will be acknowledged, and paradigm shifts within the industry can be created, materiality can become a prominent factor to be considered when developing and implementing preservation processes.

The following chapter will demonstrate this in practice, through an analysis of the policy documents of two audio-visual archives. Specifically, the policy of EYE Film Museum, as well as that of the Netherlands Institute for Sound and Vision. Together with conversations with professionals of both archives, this has provided an overview of their current digital preservation practices and the environmental considerations that are made in this process. These have been sorted according to Pendergrass et al.'s categorisation, and analysed where materiality is present in these actions, as well as where the interests of other actors can be found. Together, this will provide an overview of where materiality is present in this process and how this is approached by the two institutes. This will allow for a theoretical reflection on how environmentally sustainable changes could be implemented.

Chapter 3: Sustainability in Practice

To understand how environmental impact of audio-visual preservation is approached, this research has analysed the policy documents of two Dutch audio-visual archives to understand how materiality is considered during digital preservation. This chapter will engage with the findings of this analysis to answer the question: "In what way do the Netherlands Institute for Sound and Vision, as well as EYE Film Museum, consider environmental sustainability during the preservation of their digital, audio-visual collections? To answer this question, the exact nature of the two archives will first be addressed to understand what their background is, what they preserve and what motivations drive their vision for the future. After establishing these primary goals and tasks, the following sections will engage with the findings of the research in both institutes. This consists of an analysis of both their policy documents as well as the information acquired in the conversations with professionals. This information has been categorised according to suggested paradigm shifts in appraisal, permanence, and availability, provided by Pendergrass et al.[177]

This policy analysis has been executed with a specific focus on the role of materiality in the digital preservation process. This means an analysis of, to what extent, the archives' policy showed an awareness of the materiality present in all stages of this process, as well as an understanding of the intertwinement between materiality and the future of the digital heritage itself. In which phases are material resources considered? Is there any form of contemplation regarding the life cycle of the hardware used? How is energy use mentioned in relation to the preservation process? By gaining insight into their considerations of the materiality of digital storage, this research has been able to analyse the archives' awareness of the environmental impact of digital, audio-visual heritage preservation. Additionally, through the established theoretical reflection on intra-action, both the material agency as well as the agency of human actors in this process can be acknowledged. This will provide insight into the conditions of possibility within these two archives and provide the possibility to reflect on more environmentally sustainable practices. [178]

The Netherlands Institute for Sound and Vision

In 1995, the Dutch government decided that there should be one organisation that was responsible for the collection and preservation of media and journalism in the Netherlands. This resulted in the founding of the Dutch Audiovisual Archive in 1997.[179] This original organisation was the result of a merger

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[177] A full overview of the collected data and professionals interviewed can be found in Appendix I and II.
[178] Tamboukou, "Archival research," 621-625.
[179] "Geschiedenis," Beeld en Geluid, last accessed July 27, 2022, https://www.beeldengeluid.nl/organisatie/geschiedenis.

between a multitude of organisations, and eventually renamed into the Netherlands Institute for Sound and Vision.[180] Currently, the institute expresses their ambitious practice as "saving heritage for eternity".[181] However, this goal of long-term preservation is not their only task. They also actively engage with current media developments in the industry, and attempt to do so from a "media-historic perspective".[182] Through this engagement, as the institute's website describes, they attempt to educate and "show the influence of media on one's personal life as well as society".[183] These educational practices often take place in their Media Museum, which is located both in their main building in Hilversum, as well as in their location in The Hague.

The organisation behind this institute is a foundation, as described in the research report "Digitalisering van audiovisueel erfgoed: Naar een wettelijke publieke taak" by J.M. Breemen, V.E. Breemen and P.B. Hugenholtz, that was requested by Sound and Vision.[184] This foundation is responsible for executing the public tasks that are appointed by the Dutch government, while receiving funding in order to do so.[185] While the institute states that this funding is defined in the 2008 Dutch Media Law, this law does not specifically mention the institute by name. The Media Law only describes an "institute as identified by the Minister that has the task to maintain and exploit a media archive".[186] The legal document also describes how the *NPO* is obliged to deliver their television and radio programmes to this unspecified archive, and that this institution receives a "Rijksmediabijdrage" to execute these public tasks, which would appear to be the aforementioned funding.[187] The Breemen et al. research report argues that, while the Media Law only acknowledges a company archive, Sound and Vision additionally has the task to create "permanent availability of audio-visual material" due to its historic background in the different archival institutions.[188] The authors therefore conclude that Sound and Vision, besides a company archive, is also a cultural historic archive with a specific focus on education. This is in line with the institutions that Frick called "repositories" that are responsible for storing the material produced by the external entity.[189] As Breemen et al. describe, this double function has led to the overall goal of "as much accessibility as possible, for as long as possible, and for as many users as possible".[190] This goal has shaped the preservation process within Sound and Vision, and as the authors describe too, have led to a more recent focus on the digitisation of collections as a tool to reach these objectives.

As Sound and Vision attempts to execute a public task, it is important for the archive to

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[180] Beeld en Geluid, "Geschiedenis".
[181] Beeld en Geluid, "Geschiedenis".
[182] "Newsroom," Beeld en Geluid, last accessed May 31, 2022, https://nieuws.beeldengeluid.nl/about/.
[183] "Over Beeld en Geluid," Beeld en Geluid, last accessed May 31, 2022, https://www.beeldengeluid.nl/organisatie.
[184] J.M. Breemen, V.E. Breemen and P.B. Hugenholtz, *Digitalisering van audiovisueel erfgoed: Naar een wettelijke publieke taak,* (Amsterdam: Instituut voor Informatierecht, Universiteit van Amsterdam, 2012).
[185] Beeld en Geluid, "Over Beeld en Geluid."
[186] Media Wet 2008, Paragraaf 2.2.1.1, Article 2.2.2.J, https://wetten.overheid.nl/BWBR0025028/2020-04-01#Hoofdstuk2_Titeldeel2.2_Afdeling2.2.2a_Artikel2.34a.
[187] Media Wet 2008, Paragraaf 2.2.1.1, Article 2.146.
[188] Breemen, Breemen and Hugenholtz, *Digitalisering* 12.
[189] Frick, *Preservation,* 12.
[190] Breemen, Breemen and Hugenholtz, *Digitalisering van audiovisueel erfgoed,* 43.

determine their main user demographics, and to adjust their policy accordingly. They additionally use these to categorise and design multiple portals through which users can enter and view the digital collections.[191] The first of these demographics is what *Sound and Vision* calls "private individuals".[192] This category indicates the general public who can access both the physical archive as well as the online portal www.zoeken.beeldengeluid.nl to view the collection or to request objects for private use. The second demographic are "media professionals", who are viewing and re-using the objects in the collection for productions. They can both access and request items from the collection through a specific portal called DAAN, short for Digital Audiovisual Archive Netherlands, which is inaccessible for users outside of the profession. The third demographic consists of scholars and students who access the collection for academic research. They can search and view the digital objects through a research environment called the *Media Suite*, which has been developed by the digital infrastructure *CLARIAH*.[193] This portal also includes different tools that can be used to analyse the collections and its supporting metadata. While also providing access to several collections from other institutes like EYE Film Museum, the research environment is hosted by Sound and Vision. The fourth demographic are students in primary and secondary education in the Netherlands. Sound and Vision has developed different workshops that centre around media literacy and provides programmes that educators can use in their classroom. They also have a specific portal, called *Sound and Vision at School* and offer guided tours in the museum to learn more about media history. Lastly, Sound and Vision specifies other "Audiovisual collection holders in the Netherlands" as a demographic. The institute has initiated a platform called *AVA_Net,* where these organisations are represented.[194] Here, they can network and share their industry knowledge, and follow their goal of becoming a leading example in the Netherlands on the area of digital archiving.[195]

EYE Film Museum

As EYE describes on their website, film was long not considered to be worth archiving.[196] Before the Second World War, this was simply seen as a form of entertainment and not as cultural heritage. As previously mentioned, the reconstruction after the war aggravated the idea that these objects must be protected, and the importance of audio-visual heritage in the formation of nations and identity was

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[191] "Toegang en Gebruikers", Beeld en Geluid, last accessed June 05, 2022, https://www.beeldengeluid.nl/kennis/kennisthemas/toegang-en-gebruikers
[192] Beeld en Geluid, "Toegang en Gebruikers".
[193] "About," Media Suite, last accessed June 04, 2022, https://mediasuite.clariah.nl/about.
[194] Beeld en Geluid, "Toegang en Gebruikers".
[195] Nederlands Instituut voor Beeld en Geluid, *Collectiebeleid Beeld en Geluid* (2013): 12.
[196] "75 jaar EYE Filmmuseum," Over EYE, EYE, accessed June 11, 2022, https://www.eyefilm.nl/nl/over-eye/geschiedenis.

acknowledged.[197] As EYE describes, after initiatives in Belgium and France, the Netherlands too created a film archive called the Dutch Historic Film Archive in 1946. In 1952, the archive moved to the *Stedelijk Museum,* which also created the possibility to screen more of their collection. While this eventually became the *Dutch Film Museum*, the institute was still criticised about their lack of screenings. They were considered a "closed fortress" by a government evaluation, which directly affected the funding that they received. After they were renamed EYE Film Museum, the archive eventually moved to their current location in 2012. Since then, they have worked on presenting their collections to the Dutch public as well as stimulating engagement with the rich collections that the museum has collected over the years.

This status of EYE as a museum is visible in both their goals and mission for the future, as well as their collections. Their focus is directed towards both preservation and restauration of film, as well as public screenings of objects in their collection. This collection now exists of more than 54.000 films from every genre. To preserve these objects and make them accessible to the public, the museum receives different forms of funding, among which the Ministry of Education, Culture and Science, the City Council of Amsterdam and the overall Province of North-Holland.[198] Additionally, they receive funds from the Dutch Film Funds, among others, and the museum is closely related to this organisation in more ways. They also work together in the organisation *SEE NL,* an overarching initiative that has the task to "promote Dutch film and film culture abroad".[199]

The museum describes their main task for the upcoming years as the following: "EYE sees it as its obligation to highlight the importance of film education, to offer the chance to discover film to as many children, teens and adults".[200] They elaborate on this as they describe their main goals: "Sharing knowledge in the area of film education and media literacy, developing and executing innovative national projects as well as attending to the national coordination and consultation within these areas".[201] However, just as with Sound and Vision, the goals and vision of an institute are also partly shaped by the obligations that they have in exchange for the received financial funding. This close relationship with the Dutch Film Funds, for example has also led to the obligation for the archive to store and preserve every production made with financial contributions of the Film Funds. And as history has showed, EYE has had to put a lot more resources in the direction of opening their collections for the public, which is still their primary focus today. As they describe in their Collection policy: "The activities in the area of digitisation, conservation and restauration are, for EYE, only completed when the result is displayed in a cinema, an exhibition or online".[202]

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[197] Frick
[198] "Overheid en Fondsen", Eye, last accessed June 12, 2022, https://www.eyefilm.nl/nl/steun-eye/overheid-en-fondsen#:~:text=Eye%20Filmmuseum%20ontvangt%20steun%20van,van%20educatieve%20en%20wetenschappelijke%20projecten.
[199] Stichting Eye Filmmusem*, Beleidsplan 2018-2022* (2018): 28.
[200] Stichting Eye Filmmuseum, *Activiteitenplan 2021-2024: Aanvraag in het kader van de erfgoedwet* (2021): 28.
[201] EYE, *Activiteitenplan,* 29.
[202] Stichting Eye Filmmuseum, *Collectiebeleidsplan 2018-2021* (2018): 9.

In their mission to make their collections accessible for the public, EYE does not have a specific demographic description but direct their policy to the 'general public'. Everyone is welcome in the museum, where they can find different, alternating expositions but also permanent presentations of different film projectors and other technology. Most importantly perhaps, the physical museum in Amsterdam is where they screen their films and present the collections to the public. However, they have other ways of distribution their collections. They have the option for "archival loans", where festivals from all over the world can loan specific sub-collections or films for screening. Individual films can also be requested for re-use in productions, exhibitions or to use online. EYE does not have a specific portal for this, but one can request so manually through the Film Sales Department. The only true online portal the museum has is their online platform, *EYE Film Player*. Here, they screen different titles each week, either free or for a small fee. While too a lesser extent than the collections of Sound and Vision, a small part of EYE's collection is also available in the previously mentioned, Media Suite.[203] Lastly, while not specifying specific user demographics, EYE has developed what they call "Communities" for which they have launched specific initiatives and platforms. They have developed *EXPOSED*, a platform for young film enthusiasts, and *MovieZone*, to engage you people to develop their own initiatives. Additionally, they have multiple film clubs centred around specific themes or genres.[204] These films are screened a few times a year in the museum itself.

International standards, certification and establishing future objectives

As previously stated, both archives are related to international organisations like FIAF and IFTA. Within these organisations, knowledge is shared through seminars and publications and international standards for digital preservation are formed, standards that inevitably influence both EYE and Sound and Vision.[205] One of these standards is working with the OAIS, or the Open Archival Information System.[206] This "reference model" describes the most trustworthy workflow to design a digital archive. This is one of the demands both institutes must follow, if they want to become a "Trustworthy Digital Repository", and receive the "CoreTrustSeal", a certification provided by *The World Data System of the International Science Council* and the *Data Seal of Approval.[207]* Sound and Vision was certified with this seal in December of 2020, as the first archive in the Netherlands. With this role, they state they want to strive to be a leading example in the Netherlands in the area of "digital archiving, digital

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[203] "Desmet Film Collection," Clariah, last accessed July 27, 2022. https://mediasuitedata.clariah.nl/dataset/eye-desmet-films.

[204] "Communities," Stichting Eye Filmmuseum, last accessed June 12, 2022, https://www.eyefilm.nl/nl/over-eye/communities.

[205] "About," FIAT/IFTA, last accessed July 27, 2022, https://fiatifta.org/index.php/about/; "FIAF's Mission," FIAF, last accessed July 27, 2022, https://www.fiafnet.org/pages/Community/Mission-FIAF.html.

[206] Beeld en Geluid, *Digitale Preservering,* 9.

[207] "About," CoreTrustSeal, accessed June 05, 2022, https://www.coretrustseal.org/about/.

infrastructure and knowledge dissemination".[208] This goal also leads their focus on "authenticity and integrity". Because they argue "Without this guarantee [of integrity of the objects] the material will lose its heritage value and sovereignty and the archive will lose its authority".[209] EYE is still in the process of application of this seal.[210] They state: "EYE's mission is to safeguard the collection in a sustainable and accessible manner. To maintain durability and integrity, EYE aims to make its policy and practice transparent and measurable. […] Becoming certified demonstrates that the repository is a reliable, digitally sustainable, and accessible archive".[211] This certification is therefore important for both archives and directly shapes their digital preservation process. In the introduction to the "CoreTrustSeal Trustworthy Data Repository Requirements 2020-2022", It states:

> "Certification can be an important contribution to ensuring the reliability and durability of data repositories and hence the potential for sharing data over a longer period of time. By becoming certified, repositories can demonstrate to both their users and their funders that an independent authority has evaluated them and endorsed their trustworthiness".[212]

By receiving this status, the archives therefore maintain authority in the field. At the same time, however, these requirements and international standards shape the direction of the archives and direct their focus towards the integrity of the digital collection.

This certification, together with the history of both archives as well as their demographics are all important to understand what the primary tasks and goals of both institutes are, as these will shape the final preservation process of their collections. In the case of Sound and Vision, their policy plan aimed at 2022-2026 describes their mission as: "We strengthen everyone's life in media".[213] While rather abstract, they also elaborate through providing a description of their vision: "Through keeping media heritage alive, by stimulating responsible media use and by encouraging free speech in text, image and sound, we contribute to a pluriform, creative and democratic society".[214] Here, the double function of a company archive as well as a cultural historic archive, once again becomes visible. This continues in their description of their core values, where they use key words like "Connected, surprising, progressive and trustworthy".[215] In their policy plan for the upcoming five years, the institute describes four overarching goals with each two or three more concrete steps they are planning to take. For example, as they strive to be a "Guardian of Dutch media heritage", they attempt to do so by providing

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[208] Beeld en Geluid, *Collectiebeleid,* 12.
[209] Beeld en Geluid, *Collectiebeleid,* 38.
[210] While their original documents stated that they expected approval of this seal in 2019, and thereafter in 2021, this has not happened as of yet. It is likely that this partly delayed due to the COVID-19 pandemic.
[211] EYE, *Collectiebeleidsplan,* 25.
[212] CoreTrustSeal, *CoreTrustSeal Trustworthy Data Repository Requirements 2020-2022,* 1.
[213] "Missie en Visie," Beeld en Geluid, last accessed May 31, 2022, https://www.beeldengeluid.nl/organisatie/missie-en-visie.
[214] Beeld en Geluid, "Missie en Visie".
[215] Nederlands Instituut voor Beeld en Geluid, *Iedereen Mee in Media: Meerjarenbeleidsplan 2022-2026* (2022): 8-9.

trustworthy and sustainable preservation.[216] Other goals are to "keep heritage alive", to "celebrate media", and to "strengthen the media eco-system", meaning to educate and promote media literacy.[217] In sum, their focus on accessibility is reinforced by their government appointed obligations and public nature, while their focus on integrity is shaped by the industry standard and also reinforced by authority enhancing certificates like CoreTrustSeal. Together, these two goals shape their overall policies, both those determining the formation of their collections, as well as those describing how to preserve these digital objects.

EYE, however, defines their mission in the form of three distinct roles. The first is their position as a "treasure keeper" with which they mean their task to collection, contextualise, and share this material with the public. Secondly, their role as a "guide", meaning to curate and to make the collections accessible. Lastly, they describe their role as a "pioneer", where they are always working to develop new ways to restore, curate and present the collections.[218] While these descriptions have some overlap with how Sound and Vision describes their main goals, what is striking in these three roles is that availability of the collections is present in all three. This is in line with how the museum was historically motivated by outside obligations to make their collections more accessible, as well as with the determination that was also present in their collection policy, that their work is only finished when the material is presented to the public. They execute this in many ways, and similar too Sound and Vision, they direct a lot of their attention to keeping the medium they are preserving "alive" by providing many educational initiatives to younger generations. In sum, EYE's main mission is directed at both the preservation, as well as the presentation of the material. It is these two goals that have shaped the overall collection as well as preservation process of their digital collections.

Appraisal

The analysis of both Sound and Vision as well as EYE's policy documents regarding digital preservation has started with all actions involved in the appraisal of audio-visual objects, in line with the categorisation of Pendergrass et al. Appraisal of the material means the selection process of what does and what does not enter the collection. This has always been a crucial part of the preservation process, as appraisal creates the value and coherence of the archive. Pendergrass et al. state that this has only become more important with the digitalisation of heritage, but that digitisation has also complicated the process as it now requires a specific workflow and is dependent on "hardware and

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[216] Beeld en Geluid, *Meerjarenbeleidsplan,* 15-20.
[217] Beeld en Geluid, *Meerjarenbeleidsplan,* 30-33.
[218] EYE, *Collectiebeleidsplan*, 9-10.

software".[219] The authors argue that this stage of the preservation process is under pressure in the digital age. They write: "When these challenges are confronted with an environment where staff time is scarcer than digital storage, it can be tempting to appraise digital content in a cursory manner."[220] This means that it is now easier to simply store everything, instead of first making a strict selection. However, as established in the previous chapters, digital storage of audio-visual heritage is inherently material and therefore has an environmental impact when these material resources are accumulated and used in an unsustainable matter. Unsustainable appraisal happens when digital space is viewed differently than analogue space, and exponential growth of collections takes place. Additional impact is created through the digitisation of analogue carriers. This resource intensive process needs a lot of energy to scan all objects and process them accordingly to safeguard their integrity.[221] This also means that either an additional digital copy of the analogue object is created, which needs its own maintenance and therefore uses resources, or the analogue copy is destroyed. In both cases, this process should be reviewed to limit environmental impact.

To limit this impact during the appraisal of audio-visual heritage, Pendergrass et al. argue the professionals should be "selective in their appraisal of digital content […] to ensure that only content with enduring value is permanently retained."[222] The authors therefore suggest reviewing different actions in this stage of research. They argue for evaluating the number of objects that enter the archive, both digital-born as well as the objects that are digitised and frequently reviewing if certain objects could be removed through the process of re-appraisal. Additionally, they suggest re-considering the file formats in which objects are migrated to see if they could perhaps be stored as a smaller file. This also entails reviewing the technology used to capture and migrate these objects onto a carrier and see where energy saving measures could be implemented.[223] For this category, the policy documents of both Sound and Vision, as well as EYE have therefore been reviewed on the basis of these different actions to understand how the two archives approach the appraisal of their digital objects, and if any environmental considerations are made in this process. [224]

Digital-born Appraisal

First, this research has focussed on what automatically enters the archive on a daily basis, namely the digital-born objects. As Sound and Vision's collection policy describes, the institute previously had a

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[219] Pendergrass et al., "Sustainable," 182.
[220] Pendergrass et al., "Sustainable," 182.
[221] This is also caused by the previously mentioned fixity checks, where the complete life cycle of an object is recorded and verified.
[222] Pendergrass et al., "Sustainable," 182
[223] Pendergrass et al., "Sustainable," 182-184.
[224] The full data collected for the analysis and conclusions in this chapter can be found in Appendix II.

"strong pre-selection of the daily influx of newly aired broadcast material".[225] This changed, however, with the introduction of their digital infrastructure in 2007. This made it possible to automatically store all Dutch programmes that are broadcasted on the radio and television channels of the NPO on a daily basis and fulfil its function as, what Frick calls, a "repository".[226] Additionally, each year, the institute collects two weeks of all content aired on Dutch television, including commercial channels, promotions and commercials.[227] Their Collection Policy states that the selection of the objects now "often takes place in later stages of the archival process". It does not specify when or how this takes place. This shows a considerable difference in the attitude toward digital space in comparison to the storage of analogue objects on a shelf. Exactly as Pendergrass et al. described, when "staff is scarcer than storage", it is easier to establish one standard workflow and accept more material. This was reinforced by the conversations with the institute's professionals. Although they showed a willingness to reconsider this policy, they also stated that this would require extensive labour and resources. They made a relevant point when asked about the environmental impact of this daily storage of large quantities. They suggested that diverging from this automatic workflow could, in theory, require more energy and resources, than automatic influx. This is an important point to consider if changes should be made to this practice. Further research should provide insight into this comparison.

The policy documents and conversations with professionals at EYE showed that they do not have the same daily influx of digital-born objects as Sound and Vision does, as they are not a company archive. They state that they receive around 150 born-digital films each year.[228] The policy describes that, in principle, all Dutch productions that have been screened in Dutch cinema's will be included in the collection. Through their connections and funding organisations, there is also an agreement that EYE preserves all productions that have been established with financial support from the Dutch Film Funds, as well as the *Huber Hals Funds*. Additionally, their policy states that their "collection is further supplemented with Dutch experimental and art films, autonomous animations and all graduate productions from the Dutch Film Academy".[229] This shows that, while EYE is labelled a museum, it is also an archive. Frick distinguishes between the two, and states that an archive has the responsibility to preserve the material produced by another organisation. EYE might not be a company archive; they are still obliged to preserve these objects produced in relation to these organisations and are therefore executing archival duties. Even though the Dutch film industry does not result in the same amount of data as that which is broadcasted daily on the three NPO channels, it is still a considerable amount of digital data that needs to be stored. Just as previously argued in this research, EYE acknowledges the

[225] Beeld en Geluid, *Collectiebeleid,* 8.
[226] This research is aware of the complicated notion of 'Dutch' media objects. The definition of national, inter- or transnational media has been the centre of debate among scholars for many years. Here, the definition by Sound and Vision itself is followed, which means that programmes are produced by Dutch broadcasters and aired on the Dutch Public Service Broadcaster; Frick, *Preservation,* 12.
[227] Beeld en Geluid, *Collectiebeleid,* 49.
[228] EYE, *Collectiebeleidsplan,* 30.
[229] EYE, *Collectiebeleidsplan,* 13.

exponential increase of digital-born data offered for preservation. [230] However, they are also currently describing their acquisition process as an attempt to "identify and preserve Dutch film culture, as complete as possible" and therefore not consciously implementing a stricter selection procedure to be ready prepare for this increased influx.

The appraisal phase that Pendergrass et al. state also relates to the workflow that is in place to archive the object. This can mean the migration into specific formats and on specific hardware carriers, or the incorporation of additional information to the file, so called metadata. This also relates to the integrity checks previously mentioned, where a so-called checksum is incorporated in the file so every activity surrounding the file is recorded. This is often incorporated when the object first enters the digital collection. Sound and Vision specifically has a very insightful and accessible explanation of their workflow that can be followed from start to finish. EYE, however, does not elaborate on this too such an extent. However, they both follow the workflow model, OAIS.[231] The information in EYE's policy documents has therefore been supplemented with this information, to gain insight into which standards they follow. Both policies seemed to follow similar workflows in this area, apart from minor differentiations.

The data showed that this standard workflow exists of a fixity check to ensure that the data is complete and to verify a checksum, meaning the integrity data is checked and it can be ensured that the file is exactly as it should be. After this, the file is migrated into the standard master format of the archive. Sound and Vision mainly use MXF-formats, as they are an industry standard, but additionally use DPX files for their collections of film with "high cultural-historic importance" as this format will result in a higher resolution of the final data. Sound and vision argues that this quality is necessary because this is an "intrinsic quality of film".[232] However, as these files are not easily transported, and edited by broadcasters, Sound and Vision also makes an additional MXF file for possible re-use.[233] While the institute also provides the option for low-resolution Proxy files, these are only used for online viewing in the catalogue and are seemingly always supported by a higher quality copy.

EYE's format policy is similar, as they too use DPX as a standard format for their films, and WAV-files for sound. They additionally create a ProRes file, which is a more accessible file as this is compressed.[234] Their policy documents further describe that the standard quality of digital film is either 2k or 4k, which refers to the amount of pixels and thus the quality of the image, as this is the "minimum required resolution for theatrical release with no perceptible loss of detail".[235] In the conversations with professionals, however, it was mentioned that 4k is now often the standard quality. There is no mention of any potential lowering of the quality or the use of a smaller format size. While the policy does

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[230] EYE, *Collectiebeleidsplan,* 23.
[231] EYE, *Collectiebeleidsplan,* 23; Beeld en Geluid, *Digitale Preservering,* 9.
[232] Beeld en Geluid, *Digitale Preservering,* 20-21.
[233] Beeld en Geluid, *Digitale Preservering,* 20.
[234] EYE, *Collectiebeleidsplan,* 21.
[235] EYE, *Collectiebeleidsplan,* 21-22.

mention that a step from 2k to 4k quadruples the size of the file, there is no contemplation present on the consequences of this exponential growth in size.

After the format migration, the accompanying metadata is added, and the necessary quality checks are performed. Sound and Vision explains that this is an additional analysis on the quality of the overall file. Together with the metadata and additional data like subtitles, this is formed into an AIP, or "Archival Information Package".[236] After this, the object is stored on its material carrier. In both cases, the archives use LTO-tapes. As Tadic mentioned in her presentation, this form of storage requires a low to medium level of energy and can be stored offline, and therefore has the potential for sustainable use. However, when in service, the hardware also needs to be cooled, and while it has a life-expectancy of 30 years, Tadic mentions that the tapes are often replaced after 5-7 years, following industry standards, which is also the case in both Sound and Vision and EYE.[237]

Together, these steps form a global overview of the actions within the appraisal process of both institutions. It shows that both Sound and Vision as well as EYE are preserving a considerable number of objects and that they are focussing predominantly on high-quality storage, a decision motivated by through their focus on re-use by professionals or the screening of the objects for the public. Neither policy mentions any considerations for storing in a smaller file size for environmental concerns or even an awareness that a larger quantity of data has any environmental concerns. Additionally, the re-appraisal of the material or the check for duplicates that Pendergrass argue, and which would result in less data to store, is not present in the policy documents. While Sound and Vision does mention the removal of analogue duplicates, this policy does not extend to the digital collection. The two institutes do, however, communicate with each other to prevent overlap in their collections.

This analysis of the appraisal actions by the two archives shows that both are obliged to store a certain number of specific programmes and films, making a possible stricter selection of what will enter the collection harder to implement. However, what both policies also show is that this selection is already less of a priority when it comes to digital storage. As they are no longer limited by physical storage space, the urgency to critically appraise what enters the collection has also decreased. This also applies to the quality in which both archives store. As Pendergrass et al. suggest, this would ideally be a conscious consideration, where the uniqueness or worth of an object is balanced with environmental impact. Is the higher quality in this case worth the storage space, and therefore the resources this will require? Instead, neither of the archives seem to acknowledge this connection between quality and resources. While EYE does write that a higher resolution will quadruple the size of the file, they do not further mention that this will also require more hardware, more energy and will therefore impact the environment more. Without this awareness, neither of the archives will feel the need to make any of these balanced considerations. The appraisal policy of both archives shows that as they do not acknowledge the materiality of their digital storage, they are using this space as if it is unlimited, or to

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[236] Beeld en Geluid, *Digitale Preservering,* 32.
[237] Tadic, "Environmental Impact", slide 63.

use McIntyre and Milligan's term again, as if it is an 'infinite archive'. As this research has argued, there is a pressing need to review this. While more storage space might be available in the future through more efficient technology, Jevon's paradox has taught us that this will only result in more storage, counteracting any environmental profit. [238]

Digitisation Appraisal

The ingestion process understandably differs when it comes to the digitisation of analogue carriers. Currently, Sound and Vision digitises their collection on-demand, as this is a labour and cost-intensive task. This is now most often done when the material is either requested for re-use or when there is a need to preserve the object digitally as the analogue carrier is decaying. While this last motivation is often mentioned in relation to a need for digitisation of audio-visual heritage, most film carriers are rather sustainable for the future, as the Sound and Vision professionals explained. There are always individual exceptions, as the main concern is currently directed towards fast decaying video tapes, this turned out not to be the main motivation for most digitisation. This still seems to be accessibility and re-use. This motivation was visible when viewing the full workflow process of this digitisation process. After the analogue film was checked and manually repaired if needed, the frames where individually scanned and captured, whereafter the film was transferred to either the MXF or the DPX file format.[239] Often, when requested for re-use, each individual frame would be checked, cropped, and lightened for it to be re-used in a production. Together, this formed a resources intensive process, both financially as well as labour and energy wise.

The digitisation of analogue films at EYE is similarly motivated. Their collection policy states that digitisation happens for purposes such as "access, preservation, restauration, and presentation".[240] This process results in about 200 digitised films each year. This process is similar to Sound and Vision and exists of a scanner that individually digitised each frame into a DPX file.[241] The previously mentioned ProRes file is also colour corrected and cropped, but the original file is additionally preserved for "future restoration" of the film.[242] As the presentation and screening of their films is one of their main goals, this also seems to be a strong motivation for digitisation of the analogue objects. While some films are indeed in need of digitisation to prevent decay, the conversations showed that access and re-use are the prime motivations to do so. Their task as a museum is to present their collections, which they are now also doing digitally through YouTube and their own streaming platform. This way, they can open their collection to a wider public. In sum, while EYE does digitise on-demand, this

[238] Pendergrass et al., "Sustainable," 172.
[239] Beeld en Geluid, *Digitale Preservering,* 19.
[240] EYE, *Collectiebeleidsplan,* 21.
[241] EYE, *Collectiebeleidsplan,* 21.
[242] EYE, *Collectiebeleidsplan,* 21.

restriction is motivated because digitisation is financially and labour intensive.

As established, the digitisation process too, is inherently material. The process that transfers the analogue object to digital storage is material through its use of hardware and energy, but by digitising objects, archives are also expanding their digital collections, with already established material consequences. It must be stated that the large-scale digitisation that took place during the Images for the Future project has decreased, and while on different scales, both archives are now digitising on-demand. However, the conversations with professionals from both archives showed that this decrease was motivated because of the financial and labour intensity of the digitisation process. Environmental concern was not part of this decision, and there was little awareness of any materiality in this process at al. The opposite, the motivations of accessibility and the prevention of decay reflect the idea that digitisation of analogue carriers means that the object is immaterialised. They can now be accessed anywhere at any time. As Ercole already argued, the "safeguarding and preservation" of objects is increasingly related to its availability and both archives have shaped their policies to make this a reality.[243] However, as this research has shown, digitisation does not mean materialisation. The materiality of the objects is now just harder to see, as the archives are not directly confronted with the necessary resources needed for their hardware and energy. While on-demand digitisation is a step in the right direction, this decision does not reflect an environmentally aware paradigm.

In sum, this analysis showed where materiality is involved in the appraisal actions of the two archives. It additionally demonstrated that both archives are not aware of this matter involved. Without this awareness, there cannot be any conscious considerations where matter and impact are balanced with their other obligations. Because what a New Materialist perspective showed was that the focus of these archives is on the interests of the human actors involved. Both the Film Funds as well as the NPO are motivations to digitise their collections and to appraise more digital-born objects, as these organisations benefit from more accessibility of the collections. The decisions to digitise in such a high-quality is also related to this motivation, as it makes both screening and re-use easier. At the same time, materiality is also an agent here. As Parikka already wrote, materiality is "not just solids, and things, or even objects" and this analysis of the appraisal phase showed that materiality is present in every action of this process. [244] It is not only present, but it creates the conditions of possibility. In this case, it means that the hardware involved, including the embedded minerals and raw materials, as well as the energy involved, make it possible to store as much as these archives do. The matter involved made it possible to no longer be restricted to shelf space. However, this agency is not just positive, as it can lead to environmental impact. Additionally, it is important that archives realise that their actions are dependent on this matter. Without these resources, the current appraisal process could not function the way it does.

[243] Ercole et al., Gennari, "Cinema heritage," 1.
[244] Parikka, "New Materialism," 98.

This agency should therefore be considered during the appraisal process and balanced with the interests of human actors.

Permanence

When speaking of the permanence of the collections, this category applies to all actions related to the long-term preservation of the objects as well as their "integrity and authenticity".[245] The CoreTrustSeal requirements describe integrity as the documentation of every interaction with a document, while authenticity relates to the "degree of reliability of the original deposited data and its provenance".[246] Practically, this means that industry standards are recommending the institutes to "record, verify and periodically reverify checksums of files to ensure that file contents remain unchanged".[247] Additionally, all objects should have at least two, or sometimes even three, copies in case retrieval of the object should be necessary and files should be migrated to a new carrier every few years to prevent any loss. Together, this forms the idea of a guarantee that no material will be altered or lost over time. But all these verifications and checks come at an environmental price. For these actions to happen, the hardware and additional technology must be powered on all the time, and the hardware is discarded before it is even half-way through its life span.

This research, in line with Pendergrass et al, argues that these actions should be reviewed. In the digital age, this level of permanence that is now strived for, requires an exceptionally active form of preservation. Instead, archives can review if every action in this process is absolutely necessary for all objects in the collection. They can balance the guarantees that a specific object requires, with the resource intensity of the action in question. Archives should consider the consequences and make an informed, customized decision on what level of preservation is necessary. As Pendergrass et al. write: "Current digital preservation practices assume a goal of zero change or loss in digital collections over time. This assumption is worth investigating and challenging".[248] Or to use their terminology, when can preservation sometimes simply be "good enough"?[249]

The permanence actions of both archives have been reviewed through the analysis of the policy documents to see if this balance is present or where this could possibly be implemented. It should be noted that, for this section, this research has also reviewed the overall requirements of the CoreTrustSeal certification. While Sound and Vision provides very elaborate descriptions of their actions relating to permanence, EYE is more limited in their description of how they protect the integrity and authenticity

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[245] Pendergrass et al., "Sustainable," 184.
[246] CoreTrustSeal, *Requirements,* 11.
[247] Pendergrass et al., "Sustainable," 184.
[248] Pendergrass et al., "Sustainable," 186.
[249] Pendergrass et al., "Sustainable," 168.

of their digital collections. However, they do write that they "have the assignment to preserve the collections sustainable and accessible" and that they therefore want to "keep their policy and practice in this area insightful and measurable". To do so, they aim to be certified by the CoreTrustSeal. Therefore, it can be assumed that EYE fulfils, or aims to fulfil, many of the requirements that the certification demands. This research has therefore used the information from the requirements document, together with the policy documents to get an overview of what can be assumed, are the practices regarding permanence at EYE.

Sound and Vision's policy has many actions in place to ensure, what they call "data integrity".[250] This means that "the object is what it appears to be" and that a focus lies on the "demand of persistence". With this latter term, they mean that the digital file goes into the system, and can be extracted as exactly the same file, even on bit-level.[251] To ensure this demand, Sound and Vision uses "life-cycle management".[252] This means that integrity is ensured by executing a fixity check, both when the object enters the collection as well as after each "copy, migration and when the object is accessed".[253] With this fixity check, the 'checksum,' a form of digital finger print that is embedded in the file, is reviewed and can thereafter be compared to the "original bit-configuration" to see if any changes have taken place. [254] In practice, this means that this intensive check is done every time something happens to a file, even when it is only accessed. Through these integrity checks, Sound and Vision can hold their title as a Trustworthy Digital Repository.[255]

EYE's policy shows that every change to the data and metadata should be documented. As the fixity checks are a standard practice in audio-visual archive, it is likely that EYE executes similar fixity checks as Sound and Vision does, and that this will be carried out after every migration, change to a file or when the object is accessed. Because, as the CoreTrustSeal requirements state, these checks should "verify that a digital object has not been altered or corrupted".[256] In sum, the industry standards require that data is unchanged, and that every activity surrounding an object is recorded so this can be checked at a later stage. Without this, the archive loses its authority. But neither in Sound and Vision, or EYE, is there any reflection on the resource intensive process this requires.

As Paul Conway predicted more than 20 years ago: "The digital world transforms traditional preservation concepts from protecting the physical integrity of the object to specifying the creation and maintenance of the object whose intellectual integrity is its primary characteristic".[257] This prediction rings true when looking at the current industry standards reflected in the policies of the two archives.

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[250] Beeld en Geluid, *Digitale Preservering,* 26.
[251] With bit-level, the institute means on the level of binary digits.
[252] Beeld en Geluid, *Digitale Preservering,* 31.
[253] Beeld en Geluid, *Digitale Preservering,* 26.
[254] "Checksums als middel om de integriteit van bestanden te bewaken," Tracks, last accessed June 04, 2022, https://www.projecttracks.be/overzicht-toolbox/digitaal-bewaren/checksums-als-middel-om-de-integriteit-van-bestanden-te-bewaken; Beeld en Geluid, *Digitale Preservering,* 26.
[255] Beeld en Geluid, *Collectiebeleid,* 38.
[256] CoreTrustSeal, *Requirements,* 11.
[257] Paul Conway, *Preservation in the Digital World,* Council on Library and Information Resources (1996): 68.

When the audio-visual objects enter the digital realm, every action and movement is protected and controlled. The accessibility, and moveability of digital files, in opposition to analogue carriers on a shelf, has the downside that it costs a lot more resources to guarantee the same amount of integrity. Materiality is present in every step of the way, from the energy that it costs to check all these items, to them being powered on for each of these checks. As Pendergrass et al. also ask, is this same level of guarantee necessary for each item?[258] It is again a balance between these resources, and the standards that are expected from these archives by outside organisations. This standard, however, is very telling about the paradigm in which both Sound and Vision as well as EYE are working. This paradigm, where there is little room for environmental sustainability, must first become clear, before structural change can be implemented.

Besides a focus on the integrity of the digital objects in the collection, there is also little mention of acceptable loss in the policy documents of both institutions. The notion of acceptable loss entails that an archive accepts that, over a longer period, it is simply impossible to guarantee the preservation of every individual object. Pendergrass et al. quote David Rosenthal who states that "perfect bit-level preservation is a "myth" as the storage possibilities now are simply to unreliable.[259] Considering the environmental impact of all these prevention actions, Pendergrass et al. argue that archives should "determine acceptable levels" of potential loss.[260] The CoreTrustSeal requirements state that archives should be aware of risks in the form of "Malicious actions, human error and technical failure", however they also state that archives should determine which levels of risk are acceptable.[261] In the case of Sound and Vision, the policy predominantly describes many actions that are in place to prevent any form of loss, like storing multiple copies, and the migration of the object onto new hardware every few years. Sound and Vision uses at least two and sometimes more copies of a single file, in additional to the original carrier. Additionally, they store one copy of the complete LTO tapes in the Royal Library of the Netherlands, in case of a calamity. EYE follows a similar workflow, and also uses one uncompromised original, one projection copy and one compromised copy in the ProRes format.[262] On top of these copies, they also store one copy of each LTO-tape on a different, undisclosed location.[263] In conversations with EYE professionals, it was mentioned that a certain degree of acceptable loss is in place when it comes to analogue carriers, but that this has not yet been accepted for digital storage. This stands out, as it is especially digital storage that requires a lot more maintenance to simply keep functioning, and it would be a logical step to also formulate acceptable loss for digital carriers.

As already mentioned, replacing these tapes after only 5-7 years is also a standard in both archives. In conversation with the professionals from Sound and Vision, they explained that after this

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[258] Pendergrass et al., "Sustainable," 182.
[259] Pendergrass et al., "Sustainable," 186.
[260] Pendergrass et al., "Sustainable," 186.
[261] CoreTrustSeal, *Requirements,* 20.
[262] EYE, *Collectiebeleidsplan,* 24.
[263] EYE, *Collectiebeleidsplan,* 24.

time, certain elements from the hardware would start to be faulty and this should therefore be replaced. While this is a legitimate argument to replace the tapes earlier than the 30-year lifespan that Tadic described, their policy regarding these tapes shows a lack of awareness of the materiality involved. Sound and Vision has no recycle plan for these carriers and it is standard practice to puncture the tapes with a whole and throw them away after the data on them is migrated onto a new carrier. This is done to protect the copywritten material stored on these objects and to ensure this is not accessible after disposal. However, what happens with the tapes after this, remains unclear, which shows that no clear policy is in place to reduce e-waste. EYE does not destroy the tapes but holds on to the old copies once the data has been migrated. However, this becomes another additional copy that is not truly necessary. While this does prevent e-waste, this also shows that no clear policy is in place to deal with the now redundant hardware.

This policy, or lack thereof, is in line with how Parikka described societies relationship with material resources. As he stated, we excavate the minerals used in this hardware after they have been in the ground for millions of years, only to discard them after a limited amount of use.[264] Or, as Maxwell and Miller stated, they "turn into junk overnight".[265] This means that the standard policies regarding permanence only contribute to the extensive e-waste problem that already exists. Because materiality is at every step of this process, the decisions made to retain integrity and precent loss have material consequences. This is currently not acknowledged. One way to integrate change is to recognise the "nonmediatic materialities" that Starosielski and Walker described.[266] Through acknowledgement of these minerals, and other resources used, the life cycle of the carriers is highlighted, and more responsible decisions can be made. Because, as Pendergrass et al. also state, concessions are always made, because of financial motivations or a shortage of personnel. Why not for environmental motivations? Instead of permanence, as Pendergrass et al. suggest, could the archives strive for "continuing or enduring" collections?[267]

However, positive action regarding environmental sustainability can also be found in the policy documents. One of these initiatives is the implementation of two different main levels of preservation within Sound and Vision, in line with the different preservation levels that Pendergrass et al. suggest. The first being 'Bit-preservation' which is a passive form of storage where the file is stored just as it is delivered, and its availability and long-term preservation cannot be guaranteed. The second form is 'Full preservation" or active preservation, where the file is migration, and multiple actions are taken to ensure its availability in the future.[268] Which level is appointed to a certain object is based on different factors, which the institute summarises as: Wishes and demands of the NPO, Sound and Vision itself, but also the demands by the "Designated Communities" meaning the main demographics. Additionally,

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[264] Parikka, "New Materialism," 98-99.
[265] Maxwell and Miller, *Greening,* 2.
[266] Starosielski and Walker, *Sustainable Media*, 13.
[267] Pendergrass et al., "Sustainable," 186.
[268] Beeld en Geluid, *Digitale Preservering,* 35.

this decision is influenced by the technical, possibilities, financial costs and the copyright involved.[269] These two main levels are further organised in what Sound and Vision calls, their "Preservation Menu". This menu contains further differentiation in preservation levels that can be assigned to an object or collection. Each level has a different action plan regarding how the object is stored, what data or metadata needs to be stored as well, and which form of preservation will be used, active or passive.[270]

7.3 GARANTIES EN CONTROLES

Garanties per preserveringsniveau	1a	1b	1c	2a	2b	2c
Bestanden kunnen worden teruggeleverd zoals ze aangeleverd zijn						
Bestanden veranderen niet onbedoeld na opslag						
Bestanden zijn op bestandsnaam terugvindbaar						
Opslagmedia worden periodiek vervangen						
Bestanden zijn tot op bitniveau goed opgeslagen						
Alles dat opgeslagen zou moeten worden is ook werkelijk opgeslagen						
Bestanden zijn gekoppeld aan beschrijvende metadata						
Bestanden zijn inhoudelijk terugvindbaar						
Bestanden zijn opgeslagen in een preserveerbaar archiefformaat						
De metadata voldoen aan de metadatastandaard van Beeld en Geluid						
Bestanden zijn afspeelbaar/bruikbaar voor de korte termijn						
Bestanden voldoen kwalitatief aan de geldende formaatstandaard						

7.4 PRESERVERINGSACTIES

Preserveringsacties per niveau	1a	1b	1c	2a	2b	2c
Integriteitsberekening						
Backup						
Dragervervanging						
Restore						
End-to-end-controle						
Integriteitscheck						
Formaatmigratie						
Formaatanalyse						
Kwaliteitsanalyse						
Metadata inhoudelijke check						
Metadata technische check						

Figure 1: The Sound and Vision Preservation Menu. The top chart describes the different guarantees and checks for each preservation level, and the bottom chart describes the possible preservation actions.[271]

This detailed and specified approach, instead of a one-size-fits-all approach, is in line with Pendergrass et al. who argue for customisation of preservation. For some objects, they argue, it would be sufficient

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[269] Beeld en Geluid, *Digitale Preservering,* 35.
[270] Beeld en Geluid, *Digitale Preservering,* 35.
[271] Beeld en Geluid, *Digitale Preservering,* 37.

to strive for "good enough" preservation, instead of ensured permanence.[272] This Sound and Vision menu appears to do just that. However, when looking further into these levels, the policy states that level 1a and 1b are never used for core collections of Sound and Vision.[273] Additionally, level 2a-2c contain almost every guarantee and action, leaving most restrictions only for level 1c. It could therefore first be beneficial to review of all these steps are absolutely necessary for all 2-level collections. Even more importantly, however, is that the allocation of these levels to the objects is not based on any form of environmental concern or awareness of material resources involved. Instead, this is purely assigned on the bases of the interests of other actors like the NPO, or the financial and technical possibilities in balance with the cultural-history worth of the object.

It remains, however, a form of preservation that could potentially also be implemented at EYE, who currently do not specific treatments for specific collections. When discussing this potential with the professionals at EYE, opinions differed. One employee saw the potential of such a menu and even suggested that some objects receive a top-level preservation for a certain number of years, after which the amount of care would alleviate, the other suggested that divergence from the workflow in place could perhaps only increase the amount of energy used. Either way, these conversations did show a willingness to engage with these suggestions in the future. For now, however, EYE only diverged from their high-quality digitisation if the object would be distributed online. For example, a certain lower-quality format could be used for specific films, for them to be screened on YouTube. There are, however, currently no tiers where the object is stored in a lower quality, or other preservation actions are left out, for environmental motivations.

In sum, this analysis has shown that neither archive shows any considerations of the materiality involved in creating permanence of the collections. The policy documents showed that there are many actions in place that must all uphold this permanence of both the integrity as well as the entire object in question. Together, these actions strive for sustainable practice and to uphold their authority as an archive. However, sustainability here, is related to the long-term preservation and accessibility of their collections. While it is logical to want to maintain this authority, these actions too, should be a balance between actors' interests. This balance cannot exist if materiality and its agency are not acknowledged. In the permanence actions specifically, it becomes clear that the two archives do make concessions in this area, through the preservation menu for example, but that these are often financially motivated. Why, in that case, can these concessions not be made for environmentally sustainable reasons? It is important for these archives to understand that material agency here, makes it possible to store the collections for as long as they want. What this also means is that a shortage of resources leads to the endangerment of the future of the collections as well. Sustainable use of resources would therefore also be an investment for overall sustainable preservation.

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[272] Pendergrass et al., "Sustainable," 168.
[273] Beeld en Geluid, *Digitale Preservering,* 37.

Availability

Availability as a category includes all actions that relate to the accessibility of the collections. Pendergrass et al. describe how these actions too, were complicated through the wide-spread digitisation of archival collections. They write: "As with most online resources, many users expect near-constant availability of these materials, thus many CHOs implement infrastructures and policies that can secure this "default" of instant delivery".[274] The realisation of these expectations, however, comes with an environmental cost. As the authors describe, not only does this mean that wide-scale digitisation of the collections is necessary, but on-demand accessibility also requires the carriers to be permanently powered on, to immediately serve a request.[275] As established so far, the preservation of these digital collections has its own environmental footprint, but the constant availability that is expected of digital objects required an additional layer of energy-consuming actions. While accessibility of public heritage is important, Pendergrass et al. do suggest different areas where actions can be reviewed to create a balance between this obligation and more sustainable practice.[276] This requires re-thinking which objects are going to be digitised as well as considering if on-demand delivery is necessary in all cases. Having more time for delivery would make it possible for the storage technology, like the LTO-tapes, to be powered down when not in use.

In this category, this research has first focussed on Sound and Visions motivations for digitisation of their collections. This analysis found that the institutes primary focus has been on the availability of the collections, a goal that comes back in most policy documents. This can be explained by the, previously addressed, government appointed tasks that have formed the institute's primary vision and goals for the future. Digitisation of the collections is the most fruitful way of making this audio-visual heritage more accessible for the wider public. In their policy plan for the upcoming five years, they also formulate this goal: "In 2027, 60% of the collection in the archive will be accessible online for everybody".[277] This goal therefore heavily influences their digitisation policy, and as already established, was a primary motivation for the Images for the Future project.[278] Together with preventing the loss of analogue carriers, accessibility of the collections was achieved by this wide-scale digitisation project.

Currently, about 50% of Sound and Vision's collections have been digitised, and their digitisation strategy has changed since the Images for the Future project has ended.[279] The policy documents and plans for the upcoming years show a less active approach to digitisation and the

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[274] Pendergrass et al., "Sustainable," 191-192
[275] Pendergrass et al., "Sustainable," 193-194.
[276] Pendergrass et al., "Sustainable," 191-195.
[277] Beeld en Geluid, *Meerjarenbeleidsplan,* 19.
[278] Beeld en Geluid, "Beelden voor de Toekomst".
[279] Beeld en Geluid, *Collectiebeleid,* 35.

conversations showed that this process is now approached from a more "on-demand" strategy. For most of the remaining analogue collections, except for video tapes and individual, decaying objects, analogue carriers are only digitised when they are requested, often for re-use by media professionals. Additionally, this on-demand digitisation is supplemented with a process which they call "Fast-forward digitisation" which entails that the material is quickly scanned in its entirety, in opposition to actual digitisation of each single frame, and uploaded in low quality into the online catalogue. As these formats are not suitable for re-use and only meant as a preview, they are in theory unnecessary copies. However, as the institute argues as well, it prevents unnecessary travel to the physical building to view the analogue objects, and most importantly, it prevents unnecessary full-scale digitisation. In this latter case, this means that people can view the object first, to make sure that it is indeed the programme they require before they request the entire digitisation of the object. While this research does not possess the actual numbers to compare this strategy with an on-demand digitisation of these same items, it can be stated that this could be an environmentally sustainable option to prevent unnecessary digitisation. However, it must be stated once again that, while it might be beneficial for the environmental cause, fast-forward digitisation was not implemented with that motivation in mind. Instead, it was driven by its efficiency as it requires less time, labour, and financial resources in comparison to digitisation of each and every frame.

As stated, EYE too was part of the Images for the Future project. However, as the conversations with professionals showed, the museum did have a smaller role in this project than Sound and Vision, mostly because their digitisation process happened on a smaller scale. They digitised around 7000 films, and currently have around 2 petabytes of digital data, which is still extensive but considerably less than the 25 petabytes that Sound and Vision is currently preserving.[280] After the project ended, EYE still digitised on a smaller scale, currently digitisation around 200 films each year.[281] Their motivations for this strategy are similar to Sound and Vision, as their policy also shows a primary goal of as much accessibility as possible. While the decay of analogue carriers might often be an incentive to digitise the objects, their policy reads that the current digitisation primarily happens on request from the department of Presentation and Exhibitions.[282] This means that the objects are digitised on-demand, either for access, or for "preservation, restauration or exhibition".[283] This on-demand strategy is in line with what Pendergrass et al. suggest. They do not state that digitisation should not happen in its entirety, but that the motivations and scale in which this happens should be reviewed and balanced with the material resources it requires. It is this latter reflection that is also not present in the current digitisation strategy of EYE. While their on-demand strategy does limit the resources used, this is not environmentally motivated. Digitisation is used to open their collections and fulfil their preservation

[280] Beeld en Geluid, *Digitale Preservering,* 15.
[281] EYE, *Collectiebeleidsplan,* 30.
[282] EYE, *Collectiebeleidsplan,* 3.
[283] EYE, *Collectiebeleidsplan,* 21.

goals but is limited due to the financial and labour intensity of this process.

The analysis of the digitisation policy showed that both institutes currently implement an on-demand approach when it comes to the digitisation of their analogue objects. This is already a step forward from the mass-digitisation that Pendergrass et al. criticise.[284] It would appear, however, that these practices are only limited because they require extensive financial and labour resources, and that on-demand digitisation is not yet motivated by any environmental considerations. The overall paradigm in which they work therefore does not acknowledge that accessibility too is inherently material. A potential future step could be to analyse more critically if the increased access is indeed necessary, or to at least balance this need with the material resources this requires. It is also clear, however, that the archives have little room to do so, as they are bound by obligations that makes it their primary task to keep the heritage accessible for the larger public. In the age of digitisation, as Marks also described, consumers are used to digital access of their content and as an archive, it would appear necessary to provide this for at least a part of the collections if the institutes do not want to become obsolete.[285] It will most likely prove to be a challenge to find a balance between this incentive and the environmental impact of digitisation.

Additional to the digitisation policy, this research has looked at the delivery of this digitised material. As stated, Pendergrass et al. argue for timely, but not necessarily immediate delivery of the object.[286] This approach would make it possible to power-down certain storage technologies and carriers, like the LTO-tapes, when not in use. If communicated clearly enough to the different user demographics, this environmentally sustainable action can be balanced with the primary task of accessibility. This would mean delivery of the object, but not with the on-demand, immediate speed that the internet has made a norm. In the conversations with Sound and Vision, it did become clear that they use different storage possibilities of their copies. The primary object that can be viewed in the catalogue is on the server and therefore online. This copy can be accessed immediately. There is also an LTO-tape carrier with the different AIPs in their robot, which can be accessed when required, this is called 'Nearline' and provides the timely, but not immediate delivery Pendergrass et al. suggest. Lastly, there is an offline copy where the LTO-tape is based on a shelf and must be manually accessed if required. These last two categories are preferable, as they require less energy and are therefore more environmentally sustainable. Pendergrass et al., however, argue for one of these solutions while Sound and Vision has most of their objects stored in all three categories. In one of the conversations, the professionals mentioned that there are usually even two nearline copies in the robot, which chooses the one that is closest. It should be noted that the different portals for each demographic also require their own server, making these many different entry points to the collection an energy-consuming endeavour.

EYE has a similar workflow where most of the material is stored on the LTO-tapes in the robot.

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[284] Pendergrass et al., "Sustainable," 192.
[285] Marks, "Carbon", 50-51.
[286] Pendergrass et al., "Sustainable," 192.

In this case, these are the ProRes copies that are made of each object and there are compromised and playable files specifically for access. The conversations with EYE personnel did show that access happens on a much smaller scale than it does within Sound and Vision, and that manual access, where an actual person finds the right tape, is still the most frequent way of access. However, as the policy documents read, EYE also uses a tape robot to store their LTO-tapes in, a nearline form of storage. This means that at least a part of the digital collection is not stored offline. Additionally, while their policy documents do not phrase it as such, the museum also distributes several films through their own platform as well as through YouTube. The latter alone has around one thousand objects stored. Access through this platform means that certain copies are stored online. In the conversations with EYE professionals, they questioned how much environmental profit could really be obtained in this area, because these digital collections were on such a smaller scale than Sound and Vision for example. This research argues, however, that EYE should also engage with the material consequences of this online availability. While their online collection might not be extensive as of yet, it has been established that the amount of digital data will only grow exponentially in the upcoming years.[287] The archive should therefore engage with this issue to be prepared and have a policy in place for how this increase in data will be handled and to what extend the collections should be digitally available.

The analysis therefore concludes that, when it comes to the availability of the material, both EYE as well as Sound and Vision do not acknowledge that increased digital access to their collection had environmental impact. Accessibility remains one of the primary goals of a heritage institute, and both archives are still preoccupied with the development of the digital infrastructure, and the considerable amount of maintenance that the hardware and software require. Perhaps the most telling is the following statement that can be found in the Collection policy of Sound and Vision:

> "In the digital domain, storage and accessibility cannot be separated. An outdated storage
> format cannot be reproduced and is therefore not approachable for users. The conservation of
> a digital collections is therefore measured by its direct usability. […] If the archive
> complies to the permanent demand of marketability, it means there is sustainable
> preservation. Digital sustainability of archives and collections is therefore the same as digital
> accessibility."[288]

It is exactly this standard that makes it difficult for both institutions to diverge from the norm of on-demand, digital access. The accessibility of the analogue collection, where the physical building could simply be opened for the public, cannot be transferred to the digital domain without the use of many resources, simply to keep the hardware running constantly. Together with the obligations that both archives face that require them to open up their collections as much as possible, this results in a

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[287] Tadic, "Environmental Impact," slide 9.
[288] Beeld en Geluid, *Collectiebeleid,* 36.

paradigm where constant energy supplies and newer versions of the hardware are necessary if they want to guarantee the preservation and availability of their collections in the future.

However, what should be considered is that users do not automatically demand higher quality or faster media if this is not offered, as Marks already argued.[289] Instead, low-impact media can be made attractive. While this is perhaps not the case for professionals who request the material for re-use, it is a first step towards alternative approaches where the environment can be taken into consideration. When the material resources that are involved in this process are acknowledged, and environmental concern becomes part of the decision-making process, the actions regarding availability could also be reviewed. Instead of automatically attempting for as much, as sharp, and as fast as possible, archives could also reconsider the notion of "good enough".[290] But for this, an overall paradigm change would be necessary.

In sum, the analysis found that Sound and Vision's policy regarding the availability of their collections has been shaped by legal obligations and international standards, as well as the core value that audio-visual heritage should be accessible to the public. The same has been found to be true for EYE, which additionally has had a history of criticism of them being a "closed fortress" and therefore have an emphasis on the availability of their collections. However, as this research argues, this availability is made possible through materiality and its agency. Digital access, as well as the speed with which this can be accessed is only possible because of the energy and hardware involved in this process. Without energy to have the carriers powered on, or without the technology to make digital copies of the analogue objects in the collection, this standard could not be possible. Instead, what this research also found, is that the interests of the human agents involved require them to open these collections, which now has the main priority. However, Pendergrass et al. suggest that there are multiple areas that should be reviewed, where both goals can be reached, and environmental sustainability can be balanced with accessibility of the collections. It should also be emphasised that both archives have already implemented multiple sustainable actions, like the three forms of storage that are already in place or the digitisation process on-demand. But once again, as this is not implemented because of environmental considerations, this will not be enough to create systematic change. For that, the materiality of these processes should be acknowledged. Only then, these institutions will recognise that the accessibility that they strive towards is dependent on finite, material resources.

Overall findings

Having established both the importance of digital, audio-visual heritage, as well as the environmental impact of these processes, this chapter has engaged with the current state of sustainability

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[289] Marks, "Carbon", 50.
[290] Pendergrass et al., "Sustainable," 181.

in two prominent audio-visual archives in the Netherlands. It has attempted to answer the question: In what way do the *Netherlands Institute for Sound and Vision* as well as *EYE Film Museum* consider environmental sustainability during the preservation of their digital, audio-visual collections? Through an analysis of the position of materiality and its agency in the current digital preservation policies of the two archives, this research has found that the materiality involved with digital, audio-visual preservation is currently not sufficiently acknowledged. Therefore, this chapter can conclude that there is little awareness of the environmental impact of the current preservation policy. In this analysis, it has become clear that both institutes are bound to many obligations, as well as international standards, which shape their primary objectives and final policy. This creates a predominant focus on the protection of the integrity of the digital objects, as well as their accessibility for all users. The many actions, like the frequent fixity checks and migrations are in place to ensure these two goals. Additionally, actions like frequent migration of both hardware and software, as well as the many entry points to the collections, show that both institutes are still pre-occupied with the rapidly changing nature of digital storage. The policy documents as well as the contextualising conversations showed that simply maintaining the digital collections is already a very resource intensive process, both in relation to finances, as well as labour. This research has highlighted, however, that it is also intensive in its use of material resources, which is not yet acknowledged in the overall preservation policy. While the professionals involved in this researcher all seemed interested and willing to discuss the topic of environmental sustainability, this awareness has not yet been incorporated in their policy plans for the upcoming years.

Additionally, through approaching this analysis from a new materialist perspective, this research acknowledged that materiality is not only present, but that it has agency. Practically, this means that materiality creates the conditions of possibility that allow for the preservation policy to function as it does. As stated, without minerals, raw-materials, or energy, none of the actions described in this chapter would have been possible. Digital storage has not only made this possible, but has created the possibility to store, and present the material to an unprecedented extend. Archives are no longer restricted to the space on their shelfs, or to the public to physically coming to their building. However, this agency does not only result in possibilities. This connection also leads to dependency on these material resources. In the digital age, however, this dependency has become less visible than it was in the preservation of analogue carriers. Archives are now only presented with the many possibilities that digital storage brings, but not confronted with its material consequences. This results in a paradigm where the two archives are only engaging with the interests of the human actors involved, which, as the above analysis shows, results in environmentally unsustainable action. Together, this research argues that a perspective that does not acknowledge material agency will not be able to implement an environmentally sustainable paradigm.

Instead, when this matter and its agency are acknowledged by the two archives, they will see that their preservation processes are dependent on materiality. More importantly, this will create a

paradigm where this matter is not automatically a resource, something that can be accumulated, shaped, used and discarded all for cultural practices. Instead, matter becomes an actor that intra-acts with all the other actors involved, that together shape the conditions of possibility and make the preservation process possible. Matter therefore becomes something that should be handled responsibly. Not only because of the ethical considerations about environmental impact, but because the entire preservation process will otherwise be jeopardised. For these professionals to see that the process is dependent on materiality, means that balanced decisions can be made where material resources are handled with the same amount of care that financial resources or labour are. When archives acknowledge that there is just one form of sustainability, that environmental sustainability and sustainable preservation are inherently the same thing, only then the paradigm shifts that Pendergrass et al. suggest can become a reality.

Conclusion

Eight years ago the Images for the Future project ended. After this mass-scale digitisation endeavour, Dutch archives have been further developing their digital infrastructure and attempting to adapt to this rapidly changing field. As the end-publication of the project stated, they achieved the goal of creating "sustainable preservation" of audio-visual heritage in the Netherlands.[291] Sustainable, here, meant the long-term preservation and accessibility of these collections. This research however, questioned if this form of sustainability was also durable for the future when analysed from an environmental perspective. As their end-publication also read: "The project Images for the Future may be completed; the heritage sector is still at the beginning of a new digital era".[292] Exactly because these institutions are still learning how to work with the possibilities that digital storage brings, it was important to understand if the current practices were truly sustainable in every sense of the word. Can the preservation process also adapt to a world where climate change is one of the most pressing issues and where all sectors need to adjust to be part of the solution? This research has set out to investigate if this form of sustainable preservation can go together with environmental sustainability and how archives can adapt to achieve both. Through a New Materialist perspective, it has attempted to reflect upon the relationship between the preservation process and materiality to understand how these actions impact the environment and how the archives can potentially incorporate more environmentally sustainable practices. This research therefore set out to answer the question: What matter is involved with the process of digital, audio-visual heritage preservation?

        To answer this question, chapter one of this research engaged with literature on the

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[291] Van Excel et al., *Beelden van het Verleden,* 53.
[292] Van Excel et al., *Beelden van het Verleden,* 54.

environmental impact of the overall media industry and specifically that of digital preservation. Through its focus on materiality, it concluded that digital storage impacts the environment through the energy that this process requires, as well as the unsustainable use of hardware. As this chapter specifically focussed on the life cycle of the technological objects involved, it was able to reflect upon all elements in this hardware, like raw materials and minerals, as well as how their excavation damages the planet. This also included attention to how this hardware is often prematurely discarded, which contributes to the pressing issue of e-waste and the disproportionate environmental impact this has in the Global South. Chapter two focussed on the other side of this debate, and showed what heritage is and why it is important that these audio-visual collections are preserved for future generations. This chapter elaborated upon its potential for knowledge production as well as identity formation, but also reviewed literature on how its preservation process could become more sustainable. Specifically, it engaged with the work by Pendergrass et al. who argue that environmentally sustainable change can only be implemented if archives work in a different paradigm. A paradigm where there is room for balanced considerations between the importance of heritage as well as attempts to limit environmental impact as much as possible.

To understand how these paradigm shifts can be implemented, this research approached the materiality involved from a New Materialist perspective. This approach entailed there was not just attention of where the materiality was present, but that this research reflected upon its agency within the overall preservation process. This meant acknowledging where, and how, materiality makes action possible, or where it shapes this action in a specific way. Additionally, this meant reflecting where digital preservation is dependent on matter. This provided insight into the underlying relationship between matter and our cultural practices, through reflecting how actors come together in the archive. This perspective also acknowledged human agency involved in this process, located both inside and outside of the archive in external organisations. All these human actors have influence and interests that shape what is preserved in the archive and how this is done. The concept of intra-action allowed this research to approach this entanglement from a non-anthropocentric perspective, one where all actors are shaped by each other and non-human actors are placed next to human actors, without hierarchy. Together, they all form the conditions of possibility. Analysing this intra-action in such a way provided a possibility to reflect upon the overall relationship between the human and the non-human. This showed that it is exactly this non-anthropocentric perspective that is missing, which is why material agency is often not acknowledged. This perspective focusses solely on human interests and turns matter into an automatic resource.

This theoretical insight helped to understand how the paradigm shifts that Pendergrass et al. suggest can become a reality. Through acknowledging the intra-action between all these actors, human or non-human, we can reflect more clearly upon materiality's role in the conditions of possibility. On a more practical level, this means that archives, when confronted with the role of matter in digital storage, can also accept that the preservation process is dependent on this matter. All the possibilities that digital

storage brings, from perceived limitless storage to high levels of accessibility, are possible because of its underlying materiality. However, this matter is currently not sufficiently acknowledged and used as if it is infinite. If we keep excavating, using, and discarding this matter without a second thought, we are not only created environmentally unsustainable practices, but we are actively endangering the future of these audio-visual collections.

This research therefore argues that if the paradigm in which audio-visual archives work needs to shift, they first need to engage with the materiality of digital storage. When acknowledging the dependency of the process on matter, archives should acknowledge that it is not just a resource there to accumulate and use, but that the collections' future dependents on it. This research therefore argues that there is no conflicting interest between sustainable preservation and environmental sustainability, but that there is just one form of sustainability. Environmental sustainability will inherently make the future of these audio-visual collections more viable. While the digital age has made a lot possible for the preservation of cultural heritage, the materiality involved has become harder to see as it is further removed from the process itself. A focus on non-human agency should therefore be implemented to bring this to the forefront again. Only then, a paradigm shift can be implemented. One where matter also has a seat at the table when designing what and how to preserve audio-visual heritage. Only then, conscious considerations can be made.

Practically, this insight brought the tools to both analyse the current preservation process of two Dutch audio-visual archives and provide a first orientation on how this can become more sustainable. This analysis showed that both EYE and Sound and Vision do not consider the material limitations to digital space during their appraisal process to the same extend as they do for their analogue collections. This was specifically visible in Sound and Vision's policy that showed that the selection process has become a lot less strict as they are not confronted with the acute need to limit the influx of their collections. Both archives are also obliged to strive for the utmost level of permanence, both regarding the longevity of their collections as well as their integrity, to uphold their authority as repositories. In the digital age, however, this requires a lot more interventions and overall action to maintain this same level of insurance than it does in preserving analogue collections. Neither archive seems to consciously engage with the material consequences of these actions, or any environmental impact this might have. Lastly, the digital era is categorised through its ability to open the collections to the public to an unprecedented extend. Both archives are utilizing these possibilities are adapting to the on-demand digital delivery that has become the norm, at least for a small part of their collections. While the scale of online collections is a lot bigger within Sound and Vision, neither archive seems aware of the consequences. If these digitisation policies are limited, it is done for financial motivations or shortage of personal, and not because of any potential environmental impact. Most importantly, neither archive is asking the question, when is the preservation of these digital, audio-visual collections "good enough"?

This research therefore concluded that the two archives are not actively considering the materiality involved in the digital preservation process. Firstly, the analysis showed that this is because

of the rapidly changing digital environment, and the limited financial and personal resources that these archives have, to adapt to these changes. Secondly, this research showed that they are not engaging with the matter involved because the resources that they do have are directed at serving the interests of the human agents involved, meaning external organisations like the Dutch Film Funds or the Dutch government. These human agents are crucial for the continuation of these institutions, due to their financial support. Their interests are therefore considered in designing how and what is preserved but leaves little room for acknowledging material agency in this process. It is additionally important to emphasize that acknowledgement of materiality and engagement with environmental impact should therefore not only be within the archive itself, but that these external organisations should also adapt their requirements and expectations. Archives should receive the room to adapt to the digital age and to do so in an environmentally sustainable way.

Besides this applied research of the two Dutch audio-visual archives, this research also attempted to contribute to a theoretical understanding of the relationship between materiality and culture in the digital age. Through its reflection of what the conditions of possibility in the archive can look like, this research has provided insight into how we interact with these digital spaces. Specifically, it has highlighted how the idea of digital immateriality is deployed for our cultural practices, which showed the relationship between the human and the non-human that is too often approached form a purely anthropocentric perspective, and where matter turns into an automatic resource. What this research has specifically done, is apply a new materialist perspective to practice. While the subject of materiality in the archive has been previously engaged with by scholars, the further development of these theories in relation to concrete, applied case studies is important. This research has attempted to combine this macro and micro perspective. It has engaged with theory and reflected on the relationships between culture and materiality, but it has also kept sight of the policies and obligations that the archives must engage with. This is necessary because, while knowledge on our relationship with our environment is of great importance, the urgency of global warming requires us to engage with practice and concretely present solutions that can be implemented in the near future. Without acknowledging the responsibilities and obligations of these organisations, this is not possible.

This is exactly where the New Materialist theory that this research has implemented also has its limitations. While the focus on materiality has brought a lot of insight where changes need to be implemented, this research has also showed that it is not just about materiality, or energy or even environmental impact, but that policy is a prominent factor in actual change. While materiality has its agency and can actively endanger our heritage collections if not approached sustainably, this non-human agency is no match to regulatory policy. In the end, human agents have the ability to create destruction. While this awareness is necessary to direct responsibility where it is due, reflections and knowledge about our relationship with our environment are still needed. To implement solutions, multi- and inter-disciplinary research will be necessary in the upcoming years. As our digital spaces are rapidly evolving, and both the possibilities as well as the consequences will grow exponentially in, it is the

responsibility of us as scholars to engage with the footprint of this process and to research workable solutions. As a Sound and Vision professional stated, "In the end, policy is created, and can therefore always be adjusted if necessary." For this to happen, insight into why we do the things we do must first be created.

As stated at the beginning of this research, it will automatically have certain limitations. Through focussing on specific media, but also through the nation-specificity of the case studies involved, certain results will not be universal. For this reason, future research on environmental impact of digital preservation is highly encouraged. As stated, the intra-action between the human and the non-human takes shape through each individual actor. It is therefore of great use for future analyses to look at the preservation of other media like webpages or videogames to see if the policies surrounding these processes affects these results in any way. Additionally, this research has showed that the final process has very dependent on nation specific organisations or laws, and international research is needed to see how different legislation influences the conditions of possibility. It is also encouraged to look further than official archives, and incorporate democratic archives, like YouTube, or grassroot initiatives like *The Internet Archive* in these analyses. Lastly, this research has most of all been a first orientation to the problem of environmental impact of digital, audio-visual heritage preservation. Eight years of development have shown that the Images for the Future project was just the beginning. Our digital spaces seem to develop faster than policy can be implemented. It is, however, of the utmost importance that scholars of all disciplines, as well as policy makers, archivists and government officials are working to develop solutions. For this to happen, an awareness and understanding of the problem must first be established, a goal this research has contributed to.

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Appendix I: Consulted respondents and policy documents

Respondents

Eye Film Museum

Anne Gant – Head of Film Conservation and Digital access

Giovanna Fossati – Chief Curator

Netherlands Institute for Sound and Vision

Annelies Cordes – Digitalisation, digital influx and sustainable preservation

Marjolein Steeman – Implementation of preservation plans for new formats

Tristan Zondag – Solutions Architect

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Appendix II: Collected data

Areas for sustainable decisions	Specifications	Sound and Vision
APPRAISAL		
Storage size	What is acquired and does the policy account for objects that should not be acquired?	SV is the "programme archive" of the Dutch Public Service broadcaster, the *NPO*. It therefore has the task to archive all programmes from these television and radio channels. Their collection policy states that, up until 2006, this was done with a strong selection of what to acquire each day, while since that year the digital infrastructure has made it possible to store and preserve all aired television broadcasts of the NPO. The exception to this rule is the international material that the *NPO* broadcasts, where 'international' is deemed not produced by Dutch professional in the Netherlands or recorded and broadcasted in the Netherlands (for example, BBC programmes). Key in this determination is also if the object contributes to an understanding of "Dutch audio-visual heritage". The exact nature of the agreement between the NPO and the institute can be found in the Service and Management agreements, which are not publicly accessible. Additionally, SV acquires certain donations of material, but only when these

		comply with strict selection criteria.[293] They also include relevant documentation surrounding historic broadcasts, like Viewing and Listening Rates as well as Programme Guides. Additionally, for two weeks a year (week 10 and 43), SV archives not only the NPO but all programmes on Dutch television, from public as well as commercial broadcasters. This week also includes promotions, commercials, and international programmes, which are normally excluded. While little reflection on this policy is present in the documents, the conversations with professionals from the institute did show a willingness to think about this automatic influx of alle programmes. They did, however, pointed out that diverging from the automatic workflow could potentially only cost more energy.
	What is the policy surrounding duplicates in the institute's own collection? If applicable, how often are these removed?	While the collection policy does state that analogue materials are deselected when there are duplicates, this same action is not mentioned in relation to the digital collections.
	Do duplicates exist with other collections?[294]	SV states they attempt to have as little overlap as possible with other national as well as international collections. The institute specifically coordinates this prevention of overlap with EYE Film Museum. However, they also write that it is possible that some of this material can be present, mostly in other international collections.
	Does the institute's policy demonstrate why analogue	The policy states that digitalisation of the analogue collections is done for three reasons, re-use of the material, accessibility of the material and in order

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[293] These selection criteria are relatively complex and extensive and therefore fall outside of the scope of this research. For this research question, it is important to have an idea of elaborate process these objects go through before they are included in the collection. More information of these criteria can be found in the Digital Preservation Policy as well as in the Collection Policy of Sound and Vision.

[294] This category is added due to relevance as both Sound and Vision and EYE Film Museum do communicate to prevent overlap in their collections.

	materials should be digitally available?	to preserve the material for the future. In another report on the large-scale, multi-institute digitalisation project *Beelden voor de Toekomst*, it states that the primary reasons for this project were: The decay of the analogue carriers, as well as the fact that these collections were hard to search through. Digitalisation made it possible to create infrastructures and organise the material so that it could be easily searchable for third parties.
	What file formats are used in digital-born as well as digitised objects?	The preservation master, the standard format within SV, is MXF, as this is the industry standard. It is also the standard extradition format for SV. The policy does state that they can deviate from this standard if this is in the interest of the cultural-historic importance of the data. In practice, this means that, for certain films a DPX format is used, which will result in a higher resolution for the final data, as SV argues is of importance with files from this medium. However, this means that these files are not easily transported. So, in the case of DPX files, they are made into a mezzanine XDCAM/MXF file for re-use. Thirdly, there are Proxy files, specifically MPEG-4, which are viewing copies from the original MXF preservation master. These files are in low resolution and are therefore not suitable for re-use. These files can only be viewed in the online catalogue. The policy specifically states these are not to be used outside of SV's catalogue infrastructure because no guaranties can be given on their playability.[295] Audio files are preserved standard in a BWF format, which is comprised of a WAV format with additional metadata fields. Text files, like subtitles, and photographs are stored in PDF files.
	Is there a reflection present in the policy on potentially smaller storage	While the policy documents do present argumentation that these large formats are necessary, due to the cultural-historic importance of the material

[295] It should be noted that there are exceptions to these policy standards. For example, when material is provided from private collectors in different formats. The policy specifies that agreements can be made when this occurs, and that material can possibly be transferred. These decisions all happen on individual data scale and are therefore not addressed in this research. Here, the standard process is of importance because this will provide insight into the role of materiality and environmental impact.

	formats, and is there room to consider a lower quality of material?	and possible re-use, this high-quality is stated as a non-negotiable standard. There is no reflection present on why this quality is the standard, or if this could perhaps change.
Capture and analysis	Which technologies are used to "capture, analyse and arrange digital content?"	SV uses OAIS, the Open Archive Information System, a model that recommends the influx, storage, and availability of the material in the digital archives, both digital-born as well as digitised. Their preservation policy states that it has integrated the OAIS standards as "normative" in their own digital infrastructure. SV has three forms of storage, which are used depending on the context of the material and the preservation treatment that is agreed to with the original owner of the material (in most cases the original broadcaster). The three types of storage are: - Online, on the server, creating direct access. - Nearline, on LTO-tape in the robot, with a slightly delayed access. - Offline, also on LTO-tape but on a shelve, has to manually be accessed when needed. This categorisation means that the technology used is dependent on the form of storage of the material. The most energy consuming technology is the tape robot that both stores as well as access the nearline objects, as well as the serve that stores the purely online copies. The offline storage also requires technology in the form of the LTO-tape on which the data is stored but does not require any energy or cooling as the tapes are not in use.
	What technology is used to digitise the analogue objects and how is quality ensured in these "surrogates"?	The technology used to digitise the analogue material is depending on the carrier of the original material. In regard to film, the analogue material is first manually repaired if necessary. After this, the material goes into a scanner that captures each frame manually and transfers it to either an MXF or an DPX file format. When the object is undergoing this process because it was requested for re-use, the images are then cropped and if necessary edited. SV explained that they attempt to keep the material as close to possible as

		the original, but they do crop out any perforation (the lines in the original film roll), centre the image and if necessary, lighten the image so it can be re-used. If it is not for re-use, these later steps are sometimes not performed. In the case of video, the scanning hardware would be different, and the file can be exported in its entirety.
Reappraisal	How regularly are the objects in the collections reappraised?	The policy documents state that digital files can only be deleted when the entire tape on which they are stored is emptied. The policy states that this is case specific and can happen during the selection of other material. The collection policy however, states that this most often happens during the migration of the tapes onto new hardware, which happens every 5-7 years.
	How can the objects be "deaccessioned" when they are not reappraised?	The deaccessioning process can therefore only take place if the entire LTO-tape on which the data is stored is emptied or destroyed. Single file removal is not possible.
PERMANENCE		
Determination of acceptable loss	Are there policies around forms of acceptable loss over time?	Firstly, there are Risk Management policies in place. These are based on a 10-fold of areas, from organisation to financial sustainability and technological infrastructure. In these ten areas, materiality or environmental concern is not mentioned. From these ten areas, three specific points of attention are distilled, which categories can be summarized into Financial, Service and ICT risks. This is in line with the CoreTrustSeal requirements that determine that the archive should have an overview of potential risk both through "Malicious actions, human error, or technical failure". There are additionally many specifics in the policy documents on how to prevent loss, due to copies for example. Nowhere, however, is there mention of an acceptable loss of data in the collection. In the conversations with professionals, they did acknowledge that there is always a certain percentage of loss, but this information could not be specified within the overall policy. It was also not in relation to any environmental motivations.

	Does the policy specify "tiered approaches", specifically on the basis of the "value and uniqueness" of the material?	Yes, the preservation policy of SV does use tiered approaches in the form of what they call "Preservation Menu". This holds four categories of information, what form of storage is offered, what material should be delivered, which preservation actions should be executed and what form of preservation applies to this material. The latter can be either "Full preservation" (Active), in which the file is stored and if needed, adapted to ensure accessibility in the future, and "Bit preservation" (Passive), where the file is stored the same way it enters the archive and where long-term accessibility is not guaranteed. The tiered approaches are based on these two options and include ascending levels of guaranteed "authenticity" and "Integrity".[296] However, the lower levels of preservation are only for short-term solutions, often when data cannot be transcoded into the right format at entry. The policy specifically states these lower levels of preservation (1a − 1c) do not apply to the core collection of SV.
	Does the preservation policy have "enough flexibility" to invest in sustainable preservation? What language is used around the effort and resources spent on preservation over time and does this language allow for any degree of loss over time.	While the tiered approach for preservation allows for a diversity in approaches towards preservation, from active to passive, the language used in the policy documents do so less. As the Preservation policy states: "A trustworthy preservation environment can guard itself against all possible threats from inside and outside the organisation. The financial continuity, the sustainability of the formats and the quality of the accessibility cannot be jeopardised". However, in conversation with professionals in the institution, they mentioned policies where there to be adjusted if necessary, and while these things take time, there should certainly be room for improvement, also on the issue of sustainable preservation.

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[296] Due to the extensive description of this preservation menu, this can be found in Appendix II.

Fixity check methods and frequency	How often are fixity checks executed?	Fixity checks, where the checksum is reviewed, are executed during every adjustment or movement of one version of the object when its (re)stored, during the creation of copies, migration or when it is delivered to a user. Through these fixity checks, SV makes sure that the 'bits' are identical to the content in an earlier phase. This ensures integrity of the material.
	Are there any other checks of the collections, so object specific checksums do not have to be checked as often?	The preservation policy does mention that the integrity is also ensured through monitoring of the objects during "refreshment migrations" and "access actions". This means that the integrity of the material is checked during the migration onto new hardware that happens every 5-7 years and when specific material is accessed. It does seem that this is then still controlled through control of the checksum.
Storage technologies utilized	How many copies are in online and offline storage?	The policy states that there must be at least two copies of a file on two separate locations. SV has one exchange with the *Koninklijke Bibliotheek*. This other location is necessary to ensure the safety of the material in case of on-site disasters. The policy states that the two back-up copies are stored "depending on agreements", on LTO-tape but either in the robot or offline. However, when looking further into the policy agreements, it becomes clear that the Proxy-files, which are made to be viewed in the catalogues are another copy of the material, may it be in a lower quality which accessibility cannot be guaranteed long-term. Additionally, the report mentions, there are two copies of these proxy files as well, on disk and on tape, to guarantee "continuous service". However, the policy does state that these backups are not for guarantee of the object, but to present that the proxy files must be transcoded from the MXF from scratch in case of loss. This method is therefore more "cost-effective". Additionally, there is mention of a daily back-up copy of the metadata around the files. In sum, it is hard to determine from the policy how many copies there are of every file, as this is dependent on the specific file or collection.

	On what hardware do you store digital content?	The policy state that the digital archive masters are stored on LTO-Tape. This hardware is chosen because of its reliability and cost-efficiency.
	How often does this hardware get replaced?[297]	The LTO-tapes must be replaced every 5-7 years, according to industry standards that SV follows. According to SV professionals, this is done to ensure their trustworthiness as small parts of the tape will start to break down around this time.
	Is there an awareness off their life cycle, including manufacturing, transporting and disposing of this hardware?	The interviews done with SV professionals did not show a current awareness of the life cycle of the LTO-tapes used to store the material. Their manufacturing or transporting is not mentioned or accounted for in the policy documents and information this was not available at the time of questioning. When requesting information on their disposal after the data had been migrated, it turned out that these tapes are destroyed and not recycled. While they could, in theory, be re-used, this currently cannot be done through the strict regulation in place. SV punctures a whole in the tapes after migration to preserve the safety of the copywritten material on the tapes and thereafter creates a certificate so this destruction can be checked.
File format migration policies	Is it necessary to conduct (format) migrations when objects enter the collection or can this be done when the objects are requested?	Migration of hardware is executed during entry of the objects in the collection, as well as at "established times" when objects are migrated to the more current carrier. According to the preservation policy, this is done due to the intensive re-use of the objects by media professionals.

The formats of the primary NPO collection are entered in the collection in the same format due to the workflow that is agreed to with the broadcaster. The only mention of other format migrations in the policy document states that this is done in consultation with the NPO. |
| | Does the migration policy differ according to the material, are for | Currently, tiered approached are not used for the planning of migration, or this is at least not specified in the SV policy documents. |

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[297] Question not originally in Pendergrass et al. analysis tables.

	example, tiered approaches used to determine when material gets migrated?	
Number of redundant copies	Is there a threat model present in the policy?	While not specified as such, the "back-up guarantees" are mentioned to be dependent on the preservation level of the objects. This means that certain threats to the material are accepted regarding specific objects with a lower, and more passive preservation level.
	Could a tiered approach be implemented in regards to the number of copies of an object?	While this, in theory, could be an option, professionals of SV rightly questioned if departing from the overall workflow would be resource sufficient, or if this would only require more energy in the end.
AVAILABILITY		
Digitization	Does the institute's policy reflect a need for digitisation of the entire collection?	In the policy documents, SV argues that digitalisation of analogue material is, in some cases, necessary to ensure the future of the material in case of decay of the analogue carrier. Currently, around 50% of the collection is digitally accessible, and this process is therefore still continuing.
	If not, can this size of the process be limited while still "meeting user needs"?	SV argues that they currently are already in this process. While the initial digitalisation happened on large scale, due to the *Beelden voor de Toekomst* project, most of the material is now digitised when it is accessed by industry professionals for re-use. What the conversations with professionals showed, is that the percentage of decay of analogue film is not necessarily that urgent that large scale digitalisation is necessary. Instead, this is done for accessibility of the material and potential re-use. This does differ with other carriers, as video for example is quickly decaying and needs to be digitised for the material to be ensured in the future. The "user needs" are therefore under discussion, and should be specified in accessibility, and the safekeeping of the material.
	If there is a need for digital access to the entire collection, is there a	Currently, Sound and Vision does implement an on-demand strategy for digitalisation, which balances the need for digitalisation with the limited

	reflection on what methods to use, that meet user needs while "keeping organizational commitment to a minimum"?	resources available. However, there is no reflection on this from an environmental standpoint. Additionally, they are providing as much digital access as possible due to their fast-digitisation project.
	Is there an on-demand digitisation policy?	While not presented as such in the policy documents, the digitisation policy of Sound and Vision is currently on-demand. This means that it is either done when requested, or, in exceptions, when there is urgent need due to decay of the analogue carrier.
	If there is an on-demand digitisation policy, is this communicated to users to prevent unnecessary travel and therefore strain on the environment?	The digitalisation policy is clearly outlined on the website. Digitalisation on-demand happens for professionals, or in exchange for financial compensation. This policy is also clearly outlined online. The SV website does state that users can reserve a slot to view the material when necessary. It should be noted that the interview with professionals showed that certain material is now fast-forward digitised. This entails that the material is quickly scanned and placed, in low quality online to view. This does indeed make the collection more accessible, but also prevents actual travel to the archive to view material. It also prevents unnecessary high-quality digitalisation of material, meaning to prevent users to request and pay for the digitalisation of the material to then find out that it is indeed not the right object, or not what they needed.
Access storage	Is the migrated content always on an accessibly copy or is this done, only when the material is requested?	While not explicitly specified in the policy documents, the migration policy does not differentiate between migrated content or not. The policy on copies would appear to be collection-wide, without any distinction in workflow when material is migrated onto another carrier.
	Is it possible to power down the system that holds the copies?	This depends on the type of copy. As stated, LTO-tape copies can be accessed in the robot, meaning the hardware cannot be powered down. Additionally, there is a form of passive storage where the material is on a shelf, and therefore not using any resources.

Purple: Digital Preservation Policy Netherlands Institute for Sound and Vision.
Green: Collection policy Netherlands Institute for Sound and Vision.
Blue: "Digitalisation" page Netherlands Institute for Sound and Vision.[298]
Orange: Information acquired in conversations with professionals within the Netherlands Institute for Sound and Vision.
Pink: Inquiries for private use / Collection for makers and professionals. Webpages – Netherlands Institute for Sound and Vision.[299]
Black: Information was not present in any of the policy documents.

[298] "Digitalisering," Beeld en Geluid, last accessed July 20, 2022, https://www.beeldengeluid.nl/kennis/kennisthemas/digitalisering.
[299] "Aanvragen voor privégebruik," Beeld en Geluid, last accessed July 20, 2022, https://beeldengeluid.nl/collectie/aanvragen-voor-privegebruik#:~:text=Hoe%20werkt%20het%3F,een%20website%20of%20social%20media; "Collectie voor Makers en Professionals", Beeld en Geluid, last accessed July 20, 2022, https://beeldengeluid.nl/collectie/collectie-voor-makers-en-professionals#collectiegebruiken

Areas for sustainable decisions	Specifications	EYE Film Museum
APPRAISAL		
Storage size	What is acquired and does the policy account for objects that should not be acquired?	EYE's collection policy states that they execute their museum task based on substantial, artistic, historic, cultural, and societal criteria. The institute has multiple sub-collections, namely Dutch Film, International silent film, Film related, Experimental film, Expanded cinema and animation. Their collection policy states that, in principle, they acquire and preserve all Dutch productions that have been screened at Dutch cinemas. Additionally, they acquire all recent Dutch titles that have been produced with help from the Dutch film funds. Additionally, they store films from the Huber Bals Fund. Their collection policy states that "the collection is further supplemented with Dutch experimental and art films, autonomous animations and graduation productions of the Dutch Film academy". They additionally store non audio-visual materials, so called film-related objects, like flyers, photographs, and paper archives of specific makers. They describe their goal for the sub collection of Dutch Film as the following: "EYE strives to identify and preserve Dutch film culture, as complete as possible. However, quickly following, they elaborate on their museum function where they state: "EYE strives that their collection is a museum representation of the

		important artistic developments in film history and culture. Completeness is not the goal. In short, they summarise their criteria for objects to enter their museum as: "the object has an artistic quality and or documentary value for Dutch film culture, the object is unique for the Netherlands or the world, it shows originality or is exemplary for film or cinema-culture, or the film has a specific cinematographic quality".[300] Additionally, they mention that they "strive to acquire titles and film related items that rich the focal points of the collection, fill up any gaps and that expand the possibilities to present programmes. This is also supplemented by donations of material
	What is the policy surrounding duplicates in the institute's own collection? If applicable, how often are these removed?	The collection policy does state that it has had a wide-scale removal round of duplicates when they moved into their new building and removed around 5000 analogue carriers. There is no systematic removal in place, and the policy does not specify any systematic removal of digital duplicates.
	Do duplicates exist with other collections?	The collection policy does state that they work together with Sound and Vision, and that there is constant coordination with the institute, as they have an "historic

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[300] It must be stated that this is their overall collection policy, and therefore also includes analogue films. When discussing their overall criteria, they do not distinguish between digital or analogue objects.

		overlap" as they call it. In that case, they discuss in which archive the object would be suited best.
	Does the institute's policy demonstrate why analogue materials should be digitally available?	In their collection policy, EYE states that analogue films are digitised for multiple reasons, namely: "access, conservation, restauration and presentation". They elaborate that incidentally, films are digitised just for access, for example when they need a single sequence of re-use or if they want to research how a film can be restored. They also mention that they offer digitisation to professionals who have made an analogue film. The museum also states that their preservation activities are only successful, if screened in cinema, expositions or online. This shows that an important motivation for digitisation is accessibility of the objects.
	What file formats are used in digital-born as well as digitised objects?	The objects are digitised into a DPX-file, meaning one file for each shot, and uncompromised WAV-files for sound. These files are saved for potential future restorations. Additionally, there is a ProRes file created, that serves as an accessible and compromised file. This latter object is also corrected in colour and cropped to suit the new frame.
	In what quality is the material digitised or stored and is there reflection on possibly storing objects in lower quality?	Their policy states that they can scan in two different qualities, either 2k or 4k pixels. Most films can be digitised in 2k, as this is the minimum to be screed in cinema. However, 4k is used regarding 35mm film for example, to capture the details, as their policy states. In the interview with professionals, it was mentioned that 4k is, however, often the minimum and that there are even

		exceptions onto 6k or even 8k. This quality was necessary, these professionals stated, for presenting the films on large cinema screens. There is not an environmental reflection regarding these two options. The museum does states that digitising in 4k will quadruple the storage size of the preserved object.
Capture and analysis	Which technologies are used to "capture, analyse and arrange digital content?"	EYE follows OAIS, the Open Archive Information System, a model that recommends the influx, storage and availability of the material in the digital archives, both digital-born as well as digitised. Digital files are checked, and 'normalised' as the collection policy states, which includes the additional of an AIP and potential metadata. After this, the files are stored uncompromised, meaning the file is not made any smaller or adjusted in any way.
	What technology is used to digitise the analogue objects and how is quality ensured in these "surrogates"?	The films are digitised through the programme *Scanity*. This technology scans each individual frame of the film and creates a DPX image with WAV-file for sound. Additionally, EYE performs digital restauration for a small number of films. As the collection policy states, these are mostly films that have been selected for screening at festivals. This means that the damaged details, like scratches, are digitally repaired. They are currently developing these techniques further.
Reappraisal	How regularly are the objects in the collections reappraised?	EYE's policy documents do not specify how often the collections are re-appraised. While they do mention that they guard against excess, this seems to relate to the

		analogue collections. Even for these collections, they have done this when relocating to their new building and do not specify any further when this is systematically done.
	How can the objects be "deaccessioned" when they are not reappraised?	While EYE does not specify how their files can be deaccessioned, it can be assumed that this happens in the same way as within Sound and Vision as they use the same hardware for their digital storage. This means that data on the LTO-tape can only be deaccessioned if all the data on that tape is, so it can be either emptied or destroyed. This makes single file removal not possible.
PERMANENCE		
Determination of acceptable loss	Are there policies around forms of acceptable loss over time?	There is no mention of any form of acceptable loss over time in the EYE policy documents. In conversations with professionals, this did come forward as an area where attention could be given to in the future. Currently, while risk acceptance is calculated regarding the analogue material, this is not the case for the digital collections. Risk acceptance could, potentially, be added to possible preservation levels in the future. Looking further into the CoreTrustSeal requirements, it is suspected that EYE follows these standards as they are attempting to receive this certification. These requirements state that there should be an overview, and proper solutions for risks through "Malicious actions, human error, or technical failure". Material resources are not mentioned.
	Does the policy specify "tiered approaches", specifically on the basis of the "value and uniqueness" of the material?	Currently, EYE does not have a tiered approach to preservation. The interviews with professionals did show a willingness to possibly implement these in the future. In

		these conversations, suggestions were made on differentiating between the highest quality or the most accessible material, in relation to the uniqueness of the object. While some films might be worth projecting on the big screen, in 6k or even 8k, other objects are more valuable on a smaller screen, in lower quality but online.
	Does the preservation policy have room for sustainable preservation? What language is used around the effort and resources spent on preservation over time and does this language allow for any degree of loss over time.	While EYE does currently not address environmental sustainability in their policy documents, this could potentially be implemented. However, their policy is mostly applied to receiving the CoreTrustSeal and therefore becoming a "sustainable" archive in the future. Currently, this therefore leaves little room for environmentally sustainable changes that go against the requirements of this seal. Conversations with professionals of the institute offered different responses. While one employee did see potential in making the preservation process more environmentally sustainable, another employee believed that most environmental profit could be found in organisational sustainability, and that the environmental impact of digitisation in EYE, due to its smaller scale, should not be the first point of attention.
Fixity check methods and frequency	How often are fixity checks executed?	It is unclear how often fixity checks are executed at EYE. This is not mentioned in any policy documents, and neither is the frequency of these checks mentioned in the CoreTrustSeal requirements.
	Are there any other checks of the collections, so object specific checksums do not have to be checked as often?	The policy documents do not mention any other checks of the collections. This is also not present in the

		CoreTrustSeal requirements or the FIAF manual for preservation. However, it is a logical conclusion that EYE too, reviews the Checksums when the files are migrated onto new hardware every 5-7 years. This would create potential to lower the frequency of the regular fixity checks.
Storage technologies utilized	How many copies are in online and offline storage?	As their Collection policy states, digital files are usually already copies of analogue carriers. Additionally, for digital files, there are two additional copies made when they enter the collections. The policy describes how there is an uncompressed master called the Digital Cinema Distribution Master, secondly there is a projection copy present, which is called the Unencrypted Digital Cinema Package which includes possible subtitles, and thirdly, a reference copy in the form of the ProRes file. This latter copy is purely for access and not meant for distribution or re-use. Additionally, their policy describes how there are two sets of LTO-tape copies that are stored at separate locations in the case of an emergency. This would appear to be outside of the three existing versions of that file.
	On what hardware do you store digital content?	The objects are stored according to the industry standard, LTO-tapes that are placed in a robot with which they can be accessed. As the conversations showed, similar to Sound and Vision, these are chosen because they are cost-effective and reliable.
	How often does this hardware get replaced?	According to the policy documents, the LTO-tapes are replaced "after a few years" but according to industry standards, the data on these tapes is most likely migrated

		onto a newer version of the hardware, after 5-7 years. The professionals elaborated that the hardware is not thrown away or destroyed, but that they are stored as an additional copy.
	Is there an awareness off their life cycle, including manufacturing, transporting and disposing of this hardware?	There is no awareness in any of the policy documents of the life cycle of the hardware that is used. There is no mention of either manufacturing, transportation, or disposal of this hardware. Conversations with EYE professionals showed that the LTO-tapes do remain in use after the data on them is migrated onto a newer carrier. It must be stated that this because another copy without clear function and which is therefore not specifically necessary for preservation. There is no other recycle plan in place for when these tapes are eventually destroyed.
	Is it necessary to conduct format migrations when objects enter the collection, or can this be done when the objects are requested?	The policy documents do not specify if this would be possible. However, their Collection policy does state that maintaining compatibility across all operation systems is necessary and it would therefore seem that format migrations are necessary for digital-born material when it enters the collections.
	Is a tiered approach used when considering migration as well as format policies?	Currently, tiered approached are not used for the planning of migration, or this is at least not specified in the EYE policy documents.
Number of redundant copies	Is there a threat model present in the policy?	There is no specific threat model present in the policies. However, it does state that the number of copies are in place for "back-up purposes." However, no specific threat model is specified to the public.

	Could a tiered approach be implemented in regards to the number of copies of an object?	While this in theory could be possible, this is currently not the case in EYE's preservation policy.
AVAILABILITY		
Digitization	Does the institute's policy reflect a need for digitisation of the entire collection?	The institute describes that one of their goals is to make the collection as accessible as possible and that, in order to do so, they must digitise more films from the analogue collection. In the collection policy, it states that they process two hundred titles a year, mostly on request of the department Presentation and Exhibitions, but also because outside parties request this, or because the analogue carrier is decaying. They expect this pace to continue in the upcoming years. In conversation with professionals, it became clear that digitisation restrictions are mostly in place due to this process being both financial and labour-intensive. This was not restricted for environmental motivations. In these conversations, the professionals also stated that, while decay of analogue carriers did happen, this was in most cases not the primary motivation for digitisation. In most cases, EYE digitised analogue material because of accessibility motivations.
	If not, can this size of the process be limited while still "meeting user needs"?	This questioning was not applicable to EYE, as their digitisation policy was already limited to user needs, resulting in an on-demand digitisation process.
	If there is a need for digital access to the entire collection, is there a reflection on what methods to use,	EYE communicates that there is no need for digital access to the entire collection. However, they are attempting to publish a small part of the collection on YouTube, which

	that meet user needs while "keeping organizational commitment to a minimum"?	now already holds more than one thousand videos as well as their own streaming platform.
	Is there an on-demand digitisation policy?	Yes, EYE currently holds an on-demand digitisation policy. However, the number of reasons that films are digitised is still extensive. Their collection policy reads that films are digitised for motivations related to "access, conservation, restauration and presentation."
	If there is an on-demand digitisation policy, is this communicated to users to prevent unnecessary travel and therefore strain on the environment?	While their policy is easily accessible to the public, EYE does remain a museum and therefore stimulates users to go to their physical building and visit screenings from different films. They do make clear, however, that a certain number of films can also be viewed at home through their own streaming platform.
Access storage	Is the migrated content always on an accessibly copy or is this done, only when the material is requested? (Timely but not on-demand)	EYE does not provide on-demand access. As the professionals described in our conversations, the process is done manually. When someone requests a digital object, an employee will search for this tape. However, as the policy reads, they do have some of these tapes in the data robot as well, in nearline format. This would appear to be timely, but not on-demand access. However, the policy also describes how they are publishing objects online, on platforms like YouTube, every week. They describe how their YouTube page already has more than one thousand objects stored. These access copies are obviously online, and on a server.
	Is it possible to power down the system that holds the copies?	Similar to SV, this depends on the type of copy. As stated, LTO-tape copies can be accessed in the robot, meaning the hardware cannot be powered down. Additionally,

		there is a form of passive storage where the material is on a shelf, and therefore not using any resources.

Purple: Collection Policy EYE Film Museum.

Orange: Information acquired in conversations with professionals within EYE Film Museum.

Green: Information from EYE's webpage on home-viewing.[301]

Blue: Information required from the CoreTrustSeal requirements.

Black: Information was not present in any of the policy documents.

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[301] "Kijk en Luister thuis," EYE, last accessed July 20, 2022, https://www.eyefilm.nl/nl/kijk-en-luister.