Improving the Image Management System at The Postal Museum

London, England

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By

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Abstract

The Postal Museum in London, England plans to replace their Digital Asset Management (DAM) system to improve its preservation and organisational practices. We interviewed software vendors and museum staff and researched system features to identify potential solutions. Staff tested — and we independently evaluated — six systems to determine the optimal configuration for the museum. We provided staff with a ranked list of the systems. The highest-ranked systems had intuitive user interfaces and simple designs, which museum staff particularly valued.

Acknowledgments

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Executive summary

For thousands of years, libraries, museums, and other institutions that preserve and distribute knowledge have maintained databases of text and images in various forms, from paper and ink to digital files. The form of databases has evolved over the years to improve their functionality and match modernising technology. Despite this advancement, museums still face difficulties keeping their files safe from damages caused by natural disasters and cyber-attackers. Modern museums mainly use digital asset management (DAM) systems to manage their files, and digital preservation systems to safeguard their files. A common challenge with using these modern asset management solutions is identifying the systems that efficiently meet an institution's unique needs. The Postal Museum has been operating one such DAM system, Intelligent Media Server (IMS), for eleven years, and the system has since become disorganised and difficult to use. Staff at the museum are keen to transition to a new system configuration that improves their workflow for managing digital assets and enables long-term digital preservation to maintain their historical assets. Museum staff recognise that their metadata entry practices are inconsistent and have led to a decline in asset metadata quality.

Six-step approach for finding an optimal system configuration

This project recommended a new software configuration to The Postal Museum, consisting of both a DAM and digital preservation solution. We chose our set of systems through a combination of recommendations from our host Helen Dafter, and our own market research using review websites. This set consisted of three DAM systems, three digital preservation systems, and one hybrid DAM and preservation system. See Table 1 for the set of systems.

DAM Systems	Third Light IMS	Third Light Chorus	Pimcore
Preservation Systems	Preservica	LIBSAFE Go	Islandora
Hybrid System	Orange Logic's Cortex		

Table 1: Set of systems we decided to test

Secondly, we interviewed museum staff to gather their thoughts on the necessary features for a prospective system. We collected the desired features into a list, which we shared with software vendors to allow them to tailor their software to The Postal Museum's needs. Thirdly, we met with software vendors to set up trial versions of their software that included the features requested by the museum. Fourth, we had staff test those demo versions of each system. Fifth, we completed independent analyses for each system to test various performance metrics within the demo environments. Lastly, we facilitated a focus group to collect recurring opinions on the systems, and address concerns the staff had with prospective systems. The focus group also allowed staff members to brainstorm ideas amongst each other on why they had difficulty using different systems, and collaboratively determine which systems they found easiest to use.

Findings

Our conversations with staff revealed that the IMS became disorganised due to non-standard metadata entry practices. Certain features found in new DAM and digital preservation systems can help with organisation and security, improving the management of the current system. Staff feedback from interviews, system testing, and focus group discussions informed us on which systems best fit their needs.

Standardise metadata practices: We found that the primary factor that led to the disorganisation of the previously deployed DAM system was inconsistent and non-standardized metadata entry practices. New uploads to the system did not follow any strict guidelines for metadata entry, leading to poor-quality uploads. Advanced permissions features in the new systems would allow administrative staff to develop custom metadata schemas for different

users. These permission features would be highly valuable to The Postal Museum, as their successful implementation would address the main factors that led to the disorganisation of their previous system.

Metadata management and important features: The museum staff wanted methods for inputting metadata for newly uploaded assets that were thorough, customizable, and easy to use. If the workflow for uploading assets was confusing and frustrating, staff were less likely to see themselves successfully operating the system in the future. Additionally, staff valued the ability to create temporary folders for sharing assets within and outside the organisation.

Cloud Solution: The museum manages IMS internally, with all data backups stored on local servers or shared drives. The museum set up the system in this way to minimise network bandwidth consumption, and because it was the optimal solution at the time of its implementation. Most modern systems are managed in the cloud because it is more scalable and secure than their on-premises counterparts. Shifting to a cloud alternative interests both the administrative staff and system users at The Postal Museum, because the benefits of the cloud (easily expandable storage and geographical redundancy), outweigh the benefits of local servers (complete control of assets, cheaper to operate).

Chorus and Preservica: Chorus and Preservica were the highest-rated systems by the staff. Both systems satisfy staff requests for an intuitive, fast, and simple user interface. They both score exceptionally well in our independent analyses, are cloud-based solutions, and have robust permission features to standardise metadata entry and improve organisation. Additionally, Chorus and Preservica offer the most requested features for their price point. The museum's upgrade to Chorus would come at no additional cost to their current IMS subscription, which is about £1,200 annually, while Preservica would likely cost £20,000 annually, which falls in the middle range of pricing compared to other digital preservation systems.

Recommendations

Based on our findings, we recommended that The Postal Museum use Chorus as a DAM system and Preservica as a digital preservation system. Recommendations for system

configurations include the optimal configuration, which is Chorus and Preservica, an all-in-one solution with Orange Logic's Cortex, an open-source solution with Pimcore and Islandora, and an alternative configuration with Chorus and LIBSAFE Go. Additionally, we suggested that the museum improve its organisational practices by implementing more stringent metadata entry processes, using the permissions features offered by each system, to avoid future disorganisation. Training staff members would achieve these improvements for uploading workflows. We suggest that the museum contact another research team to help with the implementation process of their chosen system configuration, as this process will be lengthy and complicated, and the success of the future system configuration will depend on successful integration. For related work, we suggest that researchers work with software vendors to find the best software solutions for their clients, but we caution researchers that this process of working with vendors can be time-consuming. We also recommend researchers test potential systems with clientele, as direct experience with each system can reveal opinions that otherwise may not have emerged if researchers only spoke to marketing representatives, or did not test the systems at all. Our methods were successful because we created a novel six-step approach tailored to The Postal Museum's specific needs, while also completing an independent analysis that took into account each system's individual performance.

Conclusion

Memory institutions serve the important societal purpose of preserving knowledge. With the advent of digital file formats, memory institutions, like The Postal Museum, have the added challenge of preserving their digital data in addition to traditional physical assets. We researched both DAM and digital preservation systems to provide the museum with a recommendation to improve digital asset organisation and preservation. We found that museum staff valued comprehensive and intuitive metadata management, virtual collections sharing features, and a user-friendly interface.

Introduction

For thousands of years, libraries, museums, and other institutions that preserve and distribute knowledge have maintained databases of text and images in various forms, from paper and ink to digital files. The form of databases has evolved over the years to improve their functionality and match modernising technology. Despite these improvements, museums still face difficulties keeping their files safe and organised. Modern museums mainly use digital asset management (DAM) systems to manage their files, and digital preservation systems to safeguard their files. The Postal Museum in London, England, established in 2004 from the British Postal Museum & Archive, uses Intelligent Media Server, or IMS, an eleven-year-old DAM system to manage its historical records. This system was put in place around 2011 and has since become outdated and disorganised. The Postal Museum's staff wanted to replace the DAM system and add a digital preservation system to protect their collections. Our team made recommendations to improve their DAM and digital preservation systems, taking into account their needs for uploading, sharing and editing files, and preserving museum-generated content.

Researchers have conducted many studies on museum databases, chiefly focusing on larger museums, or on public access to web-based databases. Hansen (2019) discussed evolving technology in museum databases and how the constant changing of systems, people, and contents can cause the data to be difficult to access. His work, however, focused on making the data accessible to laypeople, whether that is museum employees retrieving information or the public viewing historical artefacts. Additionally, researchers have explored optimising the performance and usability of database user interfaces. Bodrogi (2003) analysed the effect of chromaticity, which is the classification of colours based on hue and saturation, on the readability of a user interface. Norman (2013), highlights the importance of light and how users interact with it in a user interface. This report will show how these elements of user interface design are important, if not the most important, factors in choosing and successfully operating a new asset management configuration. The Postal Museum requires one such DAM and digital preservation configuration more specifically suited to their needs—easy searching, simple uploading, file sharing for marketing or other museum uses, and long-term preservation of historical documents.

This report is divided into four sections: a background chapter on the history of museums, databases, and The Postal Museum; methods for our research; our research findings; and our recommendations for the museum. The background chapter begins with a history of how museums preserve data, and the risks associated with their methods, then moves on to a brief history of databases, and how they are designed and used, including organisational standards and front-end user interfaces. Finally, the chapter will cover the history of The Postal Museum and its DAM system. Within the methods section, we detail how we chose the set of six new systems, gathered initial thoughts from museum staff, tested new system demos with staff, independently analysed system demos, and collected recurring staff opinions during a focus group. In the findings sections, we display results from each of our methods, detailing which systems performed best in each analytical section. Finally, in the conclusion and recommendations chapter, we compile our findings into a set of system recommendations and detail our suggested next steps for The Postal Museum and other researchers.

Museums and databases

The Great Library of Alexandria was one of the most extraordinary collections of knowledge in the ancient world. Allegedly founded by a pupil of the legendary philosopher Aristotle around 180 BCE, the library became the largest institution for preserving knowledge at the time of its inception. The library required ships passing through Alexandria, Egypt to turn over all books on board and would return copies of those books while the original would be stored in the Library of Alexandria. At its largest, historians estimate the library held nearly half a million scrolls (Phillips, 2010). As a result, the scrolls maintained generational knowledge, and philosophy, science, and history could grow at the pace of the library, instead of the pace of human memory. It was the largest early example of a memory institution, a collective focused on preserving and distributing present or historical knowledge to the public. The library was allegedly destroyed during the Palmyrene invasion in 270 CE, resulting in one of the largest setbacks in human knowledge the world ever suffered (Alexandria Library, n.d.). In the modern-day, these setbacks are less common, but can still occur; in 2018, Brazil's National Museum in Rio de Janeiro caught fire destroying more than 90% of its collection. In the time of The Great Library of Alexandria, archivists managed their data physically and had a "manageable" collection of 500,000 scrolls. Modern-day museums have the added challenge of digital preservation in addition to physical collections and can carry tens of millions of items, such as Brazil's National Museum which held about 20 million items at the time of the fire (Escobar, 2018). The unfortunate loss of collections in Alexandria and Brazil demonstrates the need for preserving ideas and history in a way that won't be corroded over time.

The mission of museums as memory institutions

More than 2000 years after the rise and fall of The Great Library of Alexandria, museums still hold a fundamental role in cultural preservation, intellectual development, and overall well-being. Museum experiences can be profound. Many visitors reflect on their visits weeks, months, or years later and still feel the various benefits. Falk (2022) organises these long-lasting effects into four categories: personal well-being, intellectual well-being, social well-being, and physical well-being, emphasising how museum experiences can affect many facets of one's life.

Information preservation is another valuable contribution that museums and memory institutions present to society. If information is digitally stored in a safe, secure way, someone who needs to reference that information can easily access and reuse it. This viewpoint of course can lead to the conclusion that information which no one currently has any use for ought to not be preserved. However, Smith (2007) argues that preserving something assigns it intrinsic value, as it may someday serve someone who desires to use it. Objects that are currently of prime importance and value to researchers will likely become antiquated in the future, and otherwise unused information may be the hidden boon of knowledge needed to propel groundbreaking research in the future. Herein lies the value of preservation. Unutilized preserved information is not useless; its value is "simply unpotentiated" (p. 12). Therefore, the very act of museums preserving information is a herculean contribution to present and future parties interested in the relevant subject area, and any loss of such information is a major setback in human progress.

Considering the importance of data preservation, how can museums continue to safeguard their collections, allowing new generations to experience the same kind of benefits that millions have enjoyed throughout history? In the times of The Great Library of Alexandria, museums held physical collections, and their organisational practices would be proprietary from place to place. Nonetheless, these early museums used meticulous documentation practices, as every new scroll acquired in Alexandria's collection would be catalogued by its author, title, length, and origin. Similar tactics would continue until the 1600s and beyond, when memory institutions abandoned exclusively local systems in favour of centralised, common standards for cataloguing, namely Sir Thomas Bodley's methodology for the systemization of texts at the Oxford University Library in 1674 (Kalita & Deka, 2021). Another well-known system is the Dewey Decimal Classification (DDC), created by American librarian Melvil Dewey in 1876, which allowed for the improved organisation of books by subject (Satija, 2013). These standards enabled groups of libraries and other institutions to share their collections with one another, train staff in a more efficient manner, and most importantly, welcome visitors without needing to brief them on the inner workings of their system.

Physical organisational standards continued to develop through the centuries, but it was not until the 1960s that computers started being used to assist in these tasks. Working under the Library of Congress, researcher Henriette Avram began working on the MARC system

(machine-readable cataloguing), which was a "protocol by which computers exchange, use[,] and interpret bibliographic information" (Kalita & Deka, 2021). This breakthrough in computer science exploded in popularity when the Library of Congress implemented the cutting-edge system in 1969, sending thousands of records to libraries across the U.S. per week. The development of the MARC standards was the first time that a library used the term "metadata" in the context of cataloguing, and this development would be a sign of what was to come as the internet era quickly approached. Metadata refers to the subsection of identifying data meant to give context to another piece of data. In a library setting, metadata would be the descriptive information about a particular book: its title, the author, the publication date, the genre, page count, and so on. This associative data is crucial to implementing and maintaining an effective and organised data storage system since smart and comprehensive metadata will allow for easy post-entry referencing and fast searching.

Various standards exist specifically for the preservation of digital assets. The General International Standard Archival Description (ISAD (G)) is a preservation standard first published in 1994 by the International Council on Archives. The goal of this standard was to introduce a similar level of digital organisation to that seen in traditional archival media such as paper and parchment (Shepherd & Smith, 2000). For more information, see Appendix A.

An Open Archival Information System (OAIS) is an archival configuration whose reference models aim to present consistent standards that aid institutions in making connections between assets in their collections, for example. The most common standard associated with an OAIS is the reference model created by the International Organization for Standardization (ISO), which was in turn built upon a recommendation by the Consultative Committee for Space Data Systems (CCSDS). OAIS standards are applicable across disciplines, with the ultimate goal of ensuring preservation within digital archiving (Lee, 2010). More details about the implementation and usage of ISO OAIS frameworks appear in Appendix B.

A history of databases

In a general sense, a database is a centralised location for information; however, the methods used to store that information have changed drastically since their inception. Databases used to be analogue, in the form of large collections of books or encyclopaedias stored in libraries, governments, or other memory institutions. Centralised data collections were used ever since people started to record information, dating back to Sumeria where merchants would record business transactions in clay (McCormack & Wagensonner, 2015). Ancient libraries, such as The Great Library of Alexandria, stored information in the form of scrolls, wax or clay tablets, or engravings in stone or metal. Later, in the Middle Ages, archivists began using parchment, or vellum, until paper was introduced to Europe in the 11th century. Storing information like this, on individual pieces of physical media, susceptible to damage, led to disaster countless times, such as the burning of the Krasiński Library in Warsaw, Poland during WWII (Borin, 1993). In the modern age, databases almost exclusively refer to a digital collection of information stored on servers. American Airlines created the first commercially successful database in the 1960s, stored on IBM servers with the goal of helping the airline deal with flight reservations. In the 1970s, an IBM fellow and mathematician Edgar F. Codd invented the relational database, which was a method of storing data in tables, with each element in the table navigable by a row and column index (Clive, 2011).

Database security

While most online systems have security in place to prevent unauthorised access, there are still frequent breaches by outside attackers. In 2018, the Australian National University had a database containing personal data for its students and staff breached (Noble, 2019). Many museums, for example, store photos, videos, and written documents online instead of keeping physical documents in a storage building, especially if some of those documents originated online. Storing these records is important for the continued operation of the museum. If a museum were to lose access to its database or possibly lose the files themselves, it would have lost important historical documents that could be vital to its mission. For a museum, this could include scanned images and archives that aren't backed up anywhere else. Fortunately, museum collections are rarely the target of attacks like this, since attackers are usually looking for

valuable personal information; however, museums should still consider security when choosing a database.

Front-end database design

Another key aspect to consider when choosing a database service is the front-end design. The user interacts with a database through the user interface or UI. Steve Jobs introduced the first graphical user interface for operating systems on home computers in 1988 with the Macintosh (Jørgensen & Myers, 2008). Before this date, users interacted with computers at the terminal level: a black screen with text that allowed a user to input predefined commands and view the output. The invention of the graphical user interface allowed computers to be used by people who didn't need to be familiar with the predefined commands. It also allowed users with low computer literacy to perform functions on a computer in an intuitive way (Asher, 2017).

A user will interact with the UI of a database, while the buttons, windows, and text inputs will transmit signals to the database at the software level. Thanks to early innovations in the field, intuitive interfaces are now at the heart of any successful computer-based system. An accessible user interface can allow new users to quickly complete their desired tasks within a given system, but as one might imagine, the path to successful operation is not always straightforward. When selecting a database, the UI will determine how the user interacts with the system and may leave the user with a poor experience if the interface is not simple and easy to use. Some databases might have more features than others, but if they aren't clearly accessible, new users cannot easily accomplish tasks.

While almost any database will allow for storing and accessing files, the features they have for tagging or organising files can differ. Some databases are better designed for public uses such as searching for particular files and allowing for rapid retrieval of information. Others are better designed for museum uses such as long-term storage and data retention rather than easy access. While both of these functions are useful, the end-user decides which type of functionality is most important. Effective UI design is just one part of the user experience, or UX, of a system. The user experience includes the user's entire interaction with a product, from the advertisements they may encounter to conversations with representatives or employees, and the design of the product itself (Nielson & Norman, n.d.). Otherwise inconspicuous details within a system's user

interface can also have dramatic effects on the end user's experience. Design choices such as menu layout, colour usage, or lack thereof, and the legibility of the information in the interface can each have unique repercussions in practice. Achieving high user comfort in these categories should be a priority for archival teams within memory institutions since the more accessible their systems are, the easier and more effective their archival practices can become.

The Postal Museum — history and system needs

The Postal Museum, formerly known as the British Postal Museum & Archive, is an independent charity tasked with protecting and sharing the rich history of the Postal System from the seventeenth century to the present day. The museum and its collection grew incrementally, and in 1895 the Post Office set aside the Muniment Room to store records. In 1969, the National Postal Museum opened, holding a small collection of stamps and records, until its closing in 1998. The museum existed as The British Postal Museum and Archive until 2017 when it moved to its current location at Calthorpe House and changed its name to The Postal Museum (Muir, 2022). The Museum's purpose is to tell the story of Britain's postal heritage in an interactive, engaging, and educational way (The Postal Museum "About", n.d). The Postal Museum brings history to life by presenting galleries of artefacts to the public, as well as offering an interactive subterranean rail system, known as The Mail Rail. As the organisation grew and the staff expanded their services to include events, exhibitions, and educational and electronic resources, its digital system for storing images and records of its collections became disorganised.

The Postal Museum currently operates an eleven-year-old DAM system called Intelligent Media Server (IMS), created by Third Light, as part of its IT server infrastructure. Over time, IMS became disorganised and ineffective due to current organisational practices employed by the museum, including a lack of proper employee training, as well as the age of the system and its contents. IMS is hosted locally at The Postal Museum rather than by a commercial cloud service because of the large volume of bandwidth needed to transfer assets between personal machines, scanners, and the final destination of the IMS database. Staff at The Postal Museum generate digital assets consisting of images, digitised documents, 3D models, HTML files, and more. At The Postal Museum, there are a variety of departments that work with the current system including Archives; Collections; IT and Systems; Marketing and Communications;

Digitisation; Philatelic Curation; and Exhibitions, Access, and Learning. Staff in each department have varying computer skills and technical knowledge; therefore, the inputted metadata for each asset in the system ranges widely. This variability in metadata over a long period of time, as well as a lack of standardised organisational practices for storing such data, eventually led to the disorganisation of the system.

The departments at The Postal Museum each have unique needs for the system, including faster upload times, multiple file format support, enhanced preservation features, remote uploading, and more. A full list of requested features appears in Appendix C. The museum intends for the new DAM system to be used internally and is additionally interested in incorporating a digital preservation system alongside the DAM system. A digital preservation system is a system put in place to ensure access to reformatted or digitally born content regardless of media failure and technological change. The Postal Museum stores valuable digitised exhibits with historical value dating back to the seventeenth century and would like these assets to be protected from damage. Staff desire a system configuration that can store and preserve these assets, while still allowing them to be quickly accessed and used for marketing or research purposes.

Methods: developing evaluative criteria for DAM systems and digital preservation systems

The goal of this project was to recommend a new Digital Asset Management (DAM) system and a digital preservation system to The Postal Museum based on museum staff input. Our team accomplished this goal through a series of objectives:

1. Interviewed staff at The Postal Museum to learn about their current system, their opinions about it, and features they desire in a new DAM system or digital preservation system.
2. Compiled a list of prospective DAM and digital preservation systems via market research.
3. Met with vendors to discuss the possibility of setting up demos with as many requested features from the preliminary interviews as possible.
4. Developed independent evaluative criteria used as supplemental information for DAM system and digital preservation system assessment.
5. Held demo sessions with The Postal Museum staff where they performed a series of tasks using the demo systems.
6. Shared post-demo surveys with The Postal Museum staff to collect their opinion on each system.
7. Facilitated a focus group that allowed the staff of The Postal Museum to discuss what they liked and disliked about each system they tested.

The methods we employed to complete these objectives included market research, semi-structured preliminary interviews, software vendor meetings, system demos, survey questions, and a focus group. In this chapter, we describe how we utilised these methods to achieve our objectives, starting with identifying all the relevant DAM or digital preservation systems on the market. Additionally, we describe how we developed our evaluative criteria, which has both museum staff-centred and independent sections. See Figure 1 for a timeline showing how we applied our methods over the course of seven weeks.

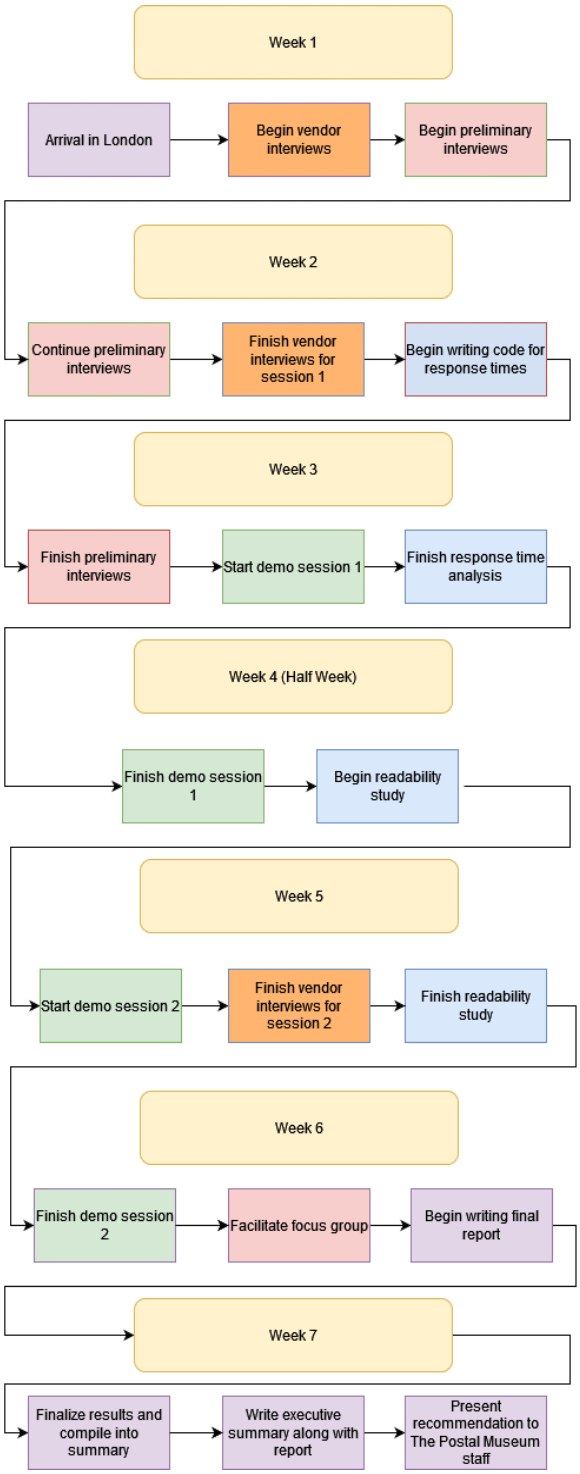

Figure 1: Timeline of objectives to recommend a DAM and digital preservation system for The Postal Museum.

Staff-centred evaluative criteria

We first identified the most desired system features amongst staff at The Postal Museum who frequently use the current DAM system. Compiling these features into a spreadsheet (see Appendix C) allowed our team to see the staff's most valued aspects of DAM systems and digital preservation systems, which we utilised as evaluative criteria to help us narrow down which software vendors we contacted, and which systems we focused on for demo testing. Additionally, we used this information to develop tasks for our demo sessions, specifically tailoring the tasks to emphasise common staff workflows.

Performing preliminary interviews with The Postal Museum staff

We created a list of staff members at The Postal Museum who interact with the DAM system frequently and would be best suited to provide feedback on the features of the current DAM system, Third Light IMS, as well as desired features in a new system. We included staff members from Archives; Collections; IT and Systems; Marketing and Communications; Photography; Philatelic Curation; and Exhibitions, Access, and Learning. Each staff member had unique ways they interacted with the DAM system, and their input was the main source of information for creating our evaluative criteria. Eight participants were interviewed for approximately 30 minutes each. The interviews were semi-structured, six were conducted in person and two were conducted over Zoom due to health concerns. During the interviews, we asked questions regarding what types of assets are managed by the current system, if staff are satisfied with the current system's workflow, and if there are features they like or dislike about the current system. For the full list of interview questions, see Appendix D. These preliminary interviews also allowed us to compile a list of features or evaluative criteria the staff would like to see enabled in a future DAM system or digital preservation system.

Creating a list of potential vendors

In addition to receiving a list of desired features, we also received recommendations from staff on DAM systems and digital preservation systems they were interested in testing. LIBNOVA's LIBSAFE Go, Preservica, and Third Light Chorus were all recommended by The Postal Museum. We reached out to WPI's Gordon Library and spoke to an Archivist there about

the university's preservation efforts. They recommended our group look into Preservica as a digital preservation system because WPI was currently in the process of creating an archive space with the system. We did research on Sourceforge.net and reviewed marketing material from top-rated DAM and digital preservation systems to find the systems that had the features requested by The Postal Museum. We considered fifteen different DAM or preservation systems before deciding on a final list of seven (six new systems) to proceed with. See Appendix E for more information about identifying systems. We also wanted to include open source solutions to add variety to the systems we wanted to test, so we added Pimcore to the list of DAM systems, and Islandora to the list of preservation systems. We tested three DAM systems, three digital preservation systems, and a hybrid system (Orange Logic's Cortex, which is a combination of both). Note that our team tested Preservica's Starter Edition, but our recommendation to the museum would be Preservica's Professional Edition, which offers more features but is very similar to the Starter Edition. The final list we created is shown below.

1. Third Light Chorus (DAM system)
2. Third Light IMS (DAM system, current museum system)
3. Pimcore (DAM system)
4. Preservica (digital preservation)
5. LIBNOVA's LIBSAFE Go (digital preservation)
6. Islandora (digital preservation)
7. Orange Logic's Cortex (DAM and digital preservation system)

Communicating DAM system requirements to vendors

After performing the preliminary interviews and compiling a list of desired features from The Postal Museum, we contacted six vendors to ask for demos of their software. We set up a Zoom call with each vendor, where we introduced ourselves as consultants for The Postal Museum, asked about features offered in their software, and asked if it could meet the needs of The Postal Museum. Generally, the vendors had a marketing and engineering representative on the call to answer questions relating to their respective departments. Four vendors also wanted to provide us with a tutorial on how to use their system, walking us through the process of uploading, downloading, sharing, and general site setup options.

Orange Logic insisted that in addition to our team, the museum staff undergo a tutorial on their hybrid system, Cortex, to ensure they understood how to use the software. This request introduced a potential limitation to our research, because tutorials by the marketing department at Orange Logic may have artificially influenced the museum staff's opinion of the software. In the meeting led by Orange Logic's marketing department, staff at The Postal Museum including the head of collections listened to persuasive rhetoric rather than evaluating the tool in an impartial manner, as was the goal with our demo sessions.

Facilitating system demo sessions with The Postal Museum staff

After obtaining access to the demo software, we performed demo sessions with the museum staff. During each session we had the participant perform a series of simple tasks using the demo system. Tasks included uploading an image, changing metadata, and sharing assets outside of the organisation. For a full list of tasks, see Appendix F. During these tasks, we asked staff to utilise a method called *Think-aloud* where the participant would verbalise their thought processes while performing each task, so we could understand their difficulties with the software, as well as recognize features they had notable success with. Lewis (1982) introduced this method to specifically test user interface design. This method of detailed observation allowed the team to iteratively identify the strong and weak points of each system (Lewis, 1982). See Appendix F for our detailed procedure for this activity. Nielsen (2000) suggests that five total participants are enough for evaluating software. More users will provide more insight, but at diminishing levels when compared to the difference between one user and five users, for example. We tested systems with eight staff members from The Postal Museum.

Different departments at The Postal Museum have different needs for the system. For example, Archivists need to quickly add and search for images while Marketing & Communications employees need to find and export groups of images easily. In order to consider these differing needs, we had members of each department participate in demo sessions to test prospective systems. Generally, a demo would take approximately ten minutes for a staff member to complete all the tasks, after which we requested the staff member complete a survey about their experience with the software. We structured the demos this way to test the key

features of each new system and to provide the participants with time to complete each survey on their own. The post-demo surveys consisted of questions about their thoughts on relevant aspects of the system's configuration for each demo, those being user interface and user experience. See Appendix G for a full list of questions regarding post-demo surveys. We asked participants to answer these questions with descriptive comments, as well as rank certain aspects on a scale of 1-5. For example, we asked participants "What did you like or dislike about the sharing feature?", and then asked them to rank the ease of sharing in the system from 1-5 (see Appendix G). This method allowed us to quantitatively compare the experiences of different users and different demos. We split the demo sessions into two parts, the first part had users test IMS, Chorus, and PIMCORE (DAM systems). The second demo session had the museum staff experiment with LIBSAFE Go, Preservica and Islandora (digital preservation systems).

Hosting a focus group

We facilitated a focus group with museum staff members who participated in the demo sessions. We performed the focus group in person with a total of five participants from different departments. Departments represented in the focus group were Archives; IT; Exhibitions, Access, and Learning; and Photography. We guided the participants through a set of discussion questions aimed to summarise and reflect upon the seven systems tested in the demos. See Appendix H for the list of questions. Departments at The Postal Museum, as well as other institutions, are generally not cognisant of the struggles or workflows of other departments. Therefore, the goal of the focus group was to have each department share the specific difficulties they faced when interacting with each system. Thus, departments were able to break these knowledge barriers and support one another by discussing aspects of these systems that may have been forgotten or unmentioned during the demo sessions or surveys. We presented a slide deck to the focus group with sections dedicated to each demo, including screenshots, to help the participants remember the different features of each system. We asked about their opinions on each system once again and shared results from their post-demo survey responses as a talking point to discuss as a group. After each demo recap, we asked the group what they liked and disliked about the system, and the participants were able to talk through their opinions with each other. This focus group session took approximately one hour, where we recorded the session and

took notes on the group's discussions. This method allowed us to gauge interest in different features and systems from a new perspective.

Independent evaluative criteria

As a supplemental evaluative method to staff-centred criteria, we independently tested multiple system attributes for all available demo systems. Islandora and Orange Logic's Cortex were unavailable for testing, so they are excluded from these tests. The set of criteria consists of two sections, page responsiveness and readability indexing. We developed these criteria based on input from staff during preliminary interviews on what they found important. For example, the staff believed that fast upload times were valuable, so we wrote scripts in Python to test the speed of the upload process.

Measuring page response times

Based on input from preliminary interviews, we found that response times from servers for login, searching, uploading, and downloading were valuable to The Postal Museum staff when discussing system preferences. In order to precisely measure response times, we automated the interactions for the login process within the system's webpages using Selenium and Python. Faster load times are desirable to the staff at The Postal Museum as they can make their daily workflows within the DAM or digital preservation system more efficient. We analysed page response times for each of the five available systems to provide a side-by-side performance comparison in our results. To view the code in its entirety, see Appendix I.

Additionally, we measured how long it takes to upload an asset to the database. This test measured page responsiveness as opposed to usability, so we performed this task in a controlled environment to minimise error. DAM systems or digital preservation systems may have different interfaces to upload an image, but assuming similar functionality, the time between an image or asset being submitted into the upload dialogue, and when it becomes available on the server, can be quantitatively measured.

We installed the Gecko driver in order for Selenium to interface with Firefox and designate the Gecko driver path as a system environment variable. We visited each webpage and recorded either the XPath or CSS selector of each input element, the submit element and an element that appears after a successful query or submission. For example, we found the XPath of the username input element in Chorus to be:
`/html/body/div/div[1]/div/div[2]/form/div[2]/div[1]/input[1]`

We passed the above XPath to the Selenium driver in order to find the element in the HTML code, and then Selenium filled it with a predefined username. The code automated the same process with the password, then found the submit button via XPath and clicked it. It's worth noting that if an element is not found by Selenium, it will throw a `NoSuchElementException`, so some experimentation was necessary to determine how long it took pages to load. We had to consider where to place delays in the code, so the elements could fully load, and Selenium could find them.

For certain tasks, we utilised OpenCV, and Python's pyautogui library to automate user interface interactions. OpenCV is a computer vision library that looks for provided images and executes commands similar to a human user. Python's pyautogui allows for the automation of user interface tasks within Python, such as moving the mouse. Additionally, XPaths for different elements would occasionally change after a few page reloads. We suspected the reason for this was different web trackers or elements that were loaded invisibly, so we switched to using an elements CSS selector for certain elements. For example, in Preservica, we timed how long it took for an image of a birth certificate to appear after the code submitted a search query, and its XPath changed frequently, so we instead looked for its CSS selector:

```
'#assetsAreaMode\~sdb\:IO\|cc34ebb2-ff82-4811-8b1d-40bf39d74a27
> div:nth-child(1)'
```

In order to measure timings, we used the `WebDriverWait` object, which we passed to the Firefox driver along with a timeout, and commanded it to idle until either the timeout elapsed or the element we were searching for loaded. Some pages took longer to load and required we pass longer timeout exceptions. The system time was recorded before the `WebDriverWait`

object began its idle, and the code recorded the system time after the `WebDriverWait` object broke its idle loop when the element loaded. Hence, the difference between these two times was taken to determine how long it took a particular element to load. We measured each time-based metric ten times and took the average of each metric for our final result.

Readability indexing

We evaluated the colour grading of each system's user interface to determine the readability of the page. All textual elements within the UI must have a minimum contrast from the background in order to be legible. We calculated the relative luminance of the pixels within textual elements and subtracted that value from the relative luminance of the background in order to determine the contrast. Higher contrasts tend to lead to greater readability (Hall & Hanna, 2004). In order to determine the general colour of the text, we took several different samples from around each site to determine the general contrast of the text against the background. See Appendix J for further details on the contrast evaluation code.

We also evaluated the font choice for each system and determined its readability by checking if it was a Serif font and if it was accessible to a range of users based on findings from Dyslexic.com. Generally, Serif fonts are considered difficult to read because the 'tails' and 'ticks' of the letters can make them difficult to read for a person with dyslexia. We inspected the font styles of each DAM and digital preservation system to determine if any system had significant readability issues. Additionally, all fonts tend to have ascenders and descenders (tails on p's and vertical lines on b's and d's) which should be long enough to clearly identify the characters. Stylized fonts may lack this differentiation in length and are a common complaint from dyslexic users (Dyslexic Staff, 2021). We looked at the source code of the web pages and noted the fonts used in the CSS styling for different parts of the page.

Results and analysis

In this section we describe our findings from our six-step methods approach. We first present feedback from staff shared during preliminary interviews. Second, we detail findings from our demo sessions, which are separated into demo session I and demo session II. Third, we have a brief section describing our experiences with, and staff's opinions about, Orange Logic's Cortex. Finally, we share results from our independent analyses.

Initial feedback on system features

Our findings from the preliminary interviews generally indicated a desire from museum staff to deploy a better DAM system and digital preservation system to fit their needs. All interviews yielded both likes and dislikes about the current system. With each interview, we summarised the feedback from staff and collated requirements for the DAM and digital preservation systems. The following sections describe the most common features and concerns highlighted by staff.

Non-standard searching and tagging

The most common complaint, apparent in all interviews, was that the current system is disorganised due to non-standard upload practices. Staff members can upload single images or groups of images from their personal devices, without placing them in the correct folder, or without properly tagging them with metadata. If items are given improper titles and tags, they become difficult to find in the system afterwards. An example given by a museum curator is that they often need to find a high-resolution image via a reference number to share with the press, but that reference number is commonly a missing part of the metadata for staff-uploaded images. Even more frustrating was that IMS would return results that are close, but not exactly the same reference number, which would clutter the search page with useless images.

Four out of eight interview participants suggested a new configuration that would prevent uploads without proper metadata. This change would prevent "data dumps" that cluttered the IMS and would instead require staff members to carefully tag and describe their uploads for

better searchability. Five interview participants suggested better training for uploading and compliance with a standardised tagging process such as the one described above.

The practicality of IMS's lightbox feature

IMS has a feature that allows users to select images while browsing and place them in a temporary collection called a "lightbox," which can then be shared via a link to people within or outside The Postal Museum organisation. Except for one participant, who didn't have a preference, all staff members we interviewed expressed positive sentiment towards the lightbox sharing feature, with some highlighting it as one of their favourite features. The positivity toward the lightbox feature is likely due to how well the feature complements the museum staff's workflows. Many staff members utilise this feature to browse for images to share with the press or other third parties and build up a collection specifically for the purpose of sharing. If staff created a new permanent folder every time they needed to share a group of images, IMS would become cluttered quickly, so the ability to create these temporary shared spaces dramatically improves the organisation of the system.

Third Light & UK-based customer support

Most staff members we interviewed never interacted with Third Light, the company behind IMS and Chorus. However, members of IT & Systems praised Third Light's customer service and would want a company that could match, or surpass, Third Light's support. The IT & Systems department explained how IMS currently exists as an on-premises solution at The Postal Museum, so their department is the first line of defence against system failures. If IT & Systems struggle to fix an issue, they have found Third Light to be responsive and effective in providing support. Third Light is a UK-based company, so they share the same working hours as The Postal Museum. IT & Systems expressed concern about hiring an American company and having to deal with time zone differences when issues arise.

Scalability and security: cloud vs. local storage

Because the current system is stored locally, and most modern DAM systems and digital preservation systems store data in the cloud, we asked staff members if they preferred cloud or local storage in a new system. The IT & Systems departments explained how there were benefits

and drawbacks to both configurations. They worried that the current internet connection at the museum would not be able to support the thousands of images a day that some staff upload, as well as the constant downloading of images from the cloud that would likely occur if a cloud-based system was implemented. This concern was validated by interviews we conducted with the Photography department, who claimed that they can upload anywhere from ten to one thousand high-resolution images in one session. Additionally, a cloud-based system could introduce corporate confidentiality concerns, as The Postal Museum stores sensitive business records for Royal Mail. However, IT & Systems staff noted that a local storage option also may not be ideal, for two reasons: security and scalability.

In terms of security, a local option is suboptimal in the case of a power outage or system failure that corrupts the local drive, jeopardising the integrity of the files. With an on-premises solution, the museum would be able to maintain control over all of its assets, alleviating concerns about confidentiality, but overall, those assets may be more secure in a cloud-based configuration. In terms of scalability, staff would need to add new hard drives manually whenever new storage is required in an on-premises setup. This method requires time and capital investment, while a cloud configuration may scale more economically and seamlessly. Ultimately, the IT & Systems department thought that the benefits of a cloud configuration outweigh the drawbacks. Two staff members expressed further concern with a cloud option, mentioning that they did not trust companies to permanently maintain their data - should the company shut down, for example.

Digital preservation integration with a DAM system

Archivists at the museum are interested in a digital preservation system that can ensure the survival of museum assets indefinitely. We asked staff from the Archives department if they would prefer a separate system with the sole purpose of preservation, or instead have the preservation aspect integrated into the DAM system. We also asked what their requirements were for an effective preservation system. The archivists believed that a digital preservation system should have geographical security, meaning that their digital assets are stored in multiple places around the world, so there is no single point of failure. Staff suggested that a digital preservation system should have version control, so any changes to file formats are recorded,

backed up, and can be restored safely. Additionally, museum archivists mentioned how a digital preservation system should also have the ability to store outdated file formats. A benefit of combining the DAM system and the digital preservation system is that all the information for the museum's digital assets would be in one system. Updates to images stored in the DAM system would automatically be preserved in the preservation system without the need to upload the same file multiple times. However, staff members expressed concern with the ability of a DAM-focused company to perform the role of both a DAM system and digital preservation system well. Staff suggested that going to a company which specifically deals with digital preservation could be preferable since they would be solely focused on keeping the assets safe and would likely have a wider variety of file support. Also, digital preservation system companies are more aware of museum archival standards and could provide a way to integrate an OAIS-compliant configuration, for example, to better preserve assets.

A system that provides an application programming interface (API) could enable the merging of both types of systems. The API could automate the communications between the DAM system and the digital preservation system, allowing for seamless asset management and preservation. Therefore, The Postal Museum could preserve its digital assets with a company that specialises in digital preservation, while also utilising a DAM system designed for easy day-to-day use.

Demo sessions - testing prospective systems

The team surveyed the participants after completing tasks in each system and the data collected from the surveys was both quantitative and qualitative. In the following sections, we describe our findings from both rounds of demo sessions, displaying quantitative results in the form of graphs, and describing common themes that emerged from qualitative data analysis.

Demo session I - testing DAM systems

Quantitative rankings

Demo session I comprised three systems: IMS, Pimcore, and Chorus. Tasks that staff completed during the demos focused on the UI of each system. In our data analysis, the user

interface consisted of three subsections: appearance, usability, and navigability. The team surveyed participants on IMS as a baseline for comparison against the new systems. For each of the following figures (Figure 2, Figure 3, and Figure 4) the vertical axis represents the staff's assigned rankings from one to five, and the horizontal axis contains each system. Higher numbers are better.

In terms of searching and sharing, Chorus scored the highest at 4.57 ± 0.5 and 4.43 ± 0.8 respectively, outclassing IMS (see Figure 2). Pimcore, however, scored lower than IMS at 3.29 ± 1.3 in terms of searching, but higher than IMS in terms of sharing, at 3.29 ± 1.0. These scores suggest that participants found the searching and sharing features of Chorus much easier to use in contrast with Pimcore, which participants found to be similarly usable to IMS. In terms of downloading, Chorus scored the highest at 4.43 ± 0.8. These results suggest participants found it easier to download and format assets in Chorus and Pimcore rather than IMS (see Figure 3). In terms of uploading, Chorus ranked the highest at 3.86 ± 0.7, outranking IMS, which scored 3.29 ± 0.8, while Pimcore scored the lowest at 2.86 ± 0.9 (see Figure 3). These results suggest that participants found it easier to upload assets in Chorus over IMS and Pimcore. In terms of UI appearance and usability, Chorus scored the highest at 4.29 ± 0.8 and 3.71 ± 0.5, respectively (see Figure 4), over both IMS and Pimcore. These results suggest that participants found Chorus' user interface more visually appealing and functional in comparison to IMS and Pimcore. Lastly, IMS scored the highest in terms of UI navigability at 3.86 ± 0.4. This relatively high score is most likely because IMS is the museum's current system, therefore participants are more familiar with navigating IMS rather than new systems such as Pimcore and Chorus.

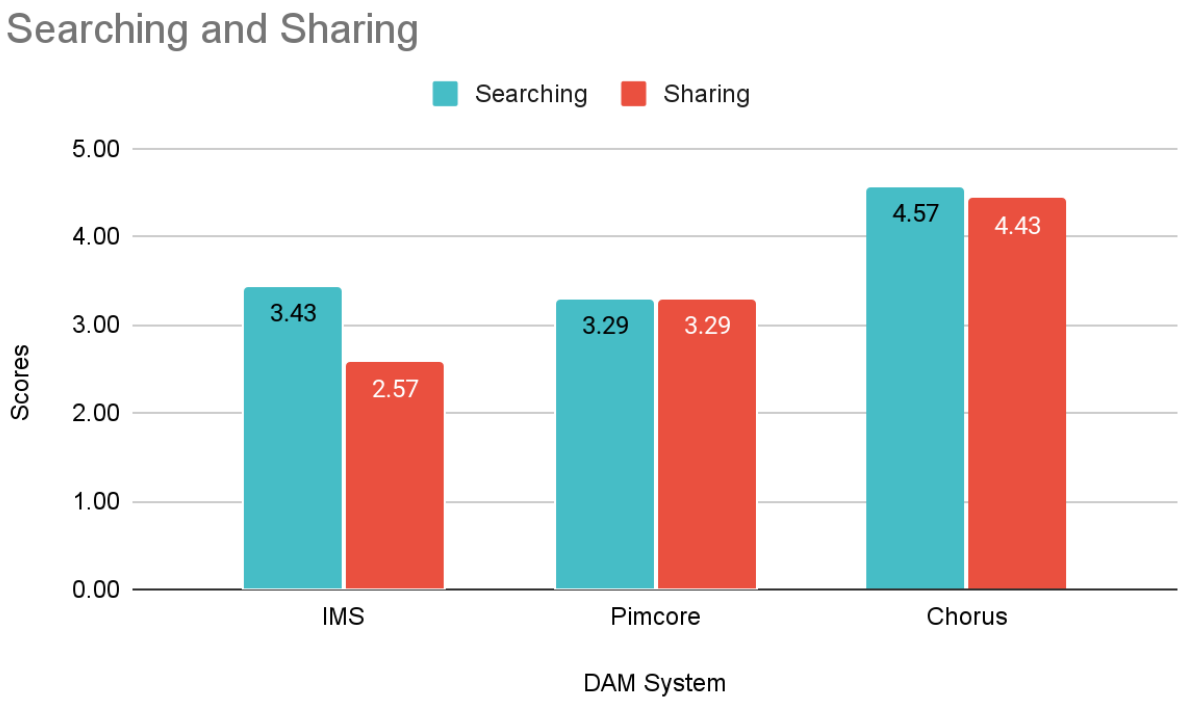

Figure 2: Average ease of use for searching and sharing features in each system from demo session I according to eight staff members.

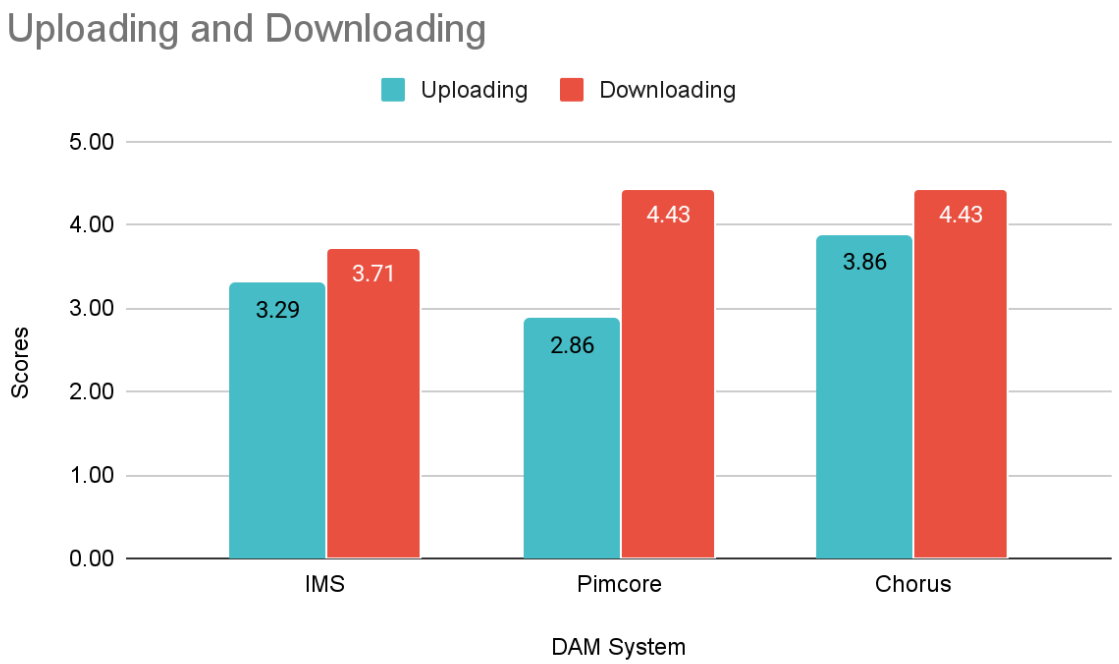

Figure 3: Average ease of use for upload and download features in each system from demo session I according to eight staff members.

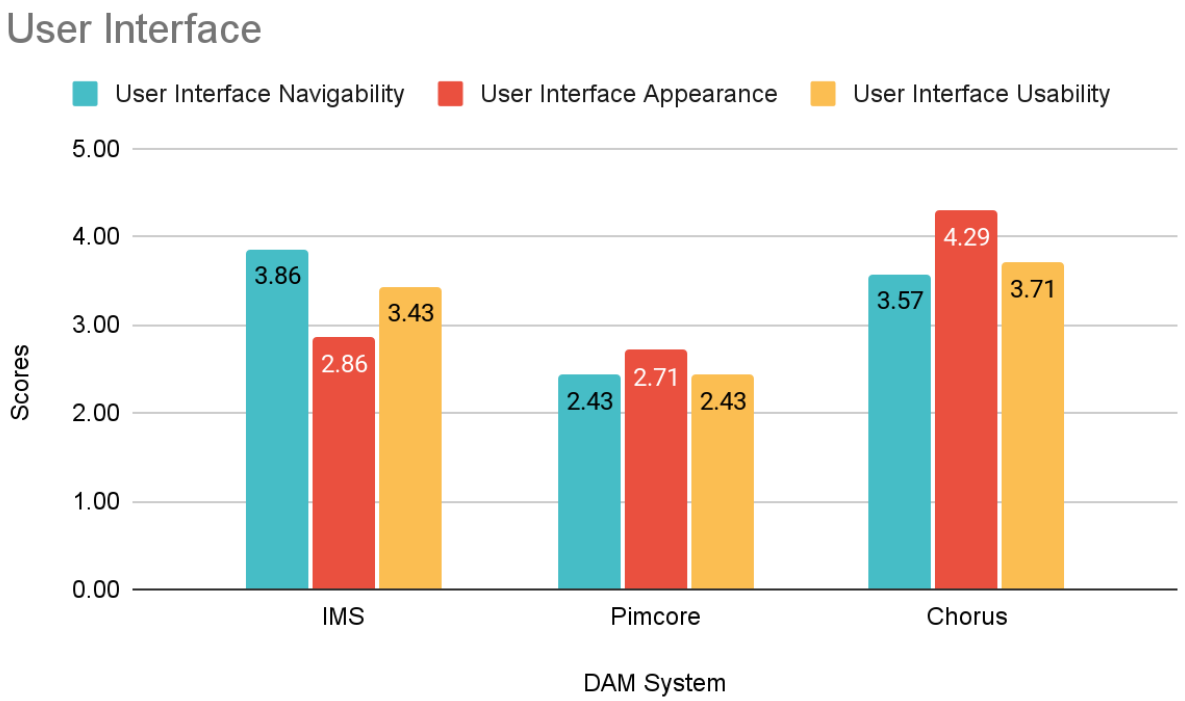

Figure 4: Average UI navigability, appearance, and usability scores for each system from demo session I according to eight staff members.

Qualitative analysis

The participants appreciated the basic features of Pimcore such as downloading, sharing, and editing metadata. Pimcore, however, was found to have a counterintuitive and difficult to navigate UI that caused frustration among participants. Pimcore also leaned heavily on custom icons for their UI, an aspect of the system that caused confusion among participants. In terms of uploading, many participants expected a drag and drop interface, where there was none, which led to frustration. The intuitive and simple design of Chorus pleased the participants. Chorus' visually rich and responsive UI garnered much praise amongst participants, as did features such as sharing, searching, and metadata editing. Two participants, however, disliked the visual formatting of the folder hierarchy within the demo, though this is a feature that The Postal Museum may customise if they implement the full system. See Appendix K for UI screenshots from Pimcore, Chorus, and IMS.

Cumulative scores

We summed and averaged the quantitative data for each DAM system to generate an overview of which systems performed best. This was a compilation of the scores relating to searchability, sharing, navigability, uploading, downloading, appearance, and usability. We used these scores as a comparative, overarching assessment of each system. Chorus was the most well-received system, with the highest average score of 4.17, with notably excellent scores in the appearance and usability of the user interface. IMS came in second with a score of 3.31, likely stemming from the staff's familiarity with the system. Pimcore scored the lowest with a score of 3.06, highly attributable to the frustrating user experience and cluttered design. See Figure 5 for more details on the cumulative scores. The vertical axis represents the staff's assigned rankings from one to five, and the horizontal axis contains each system. Higher numbers are better.

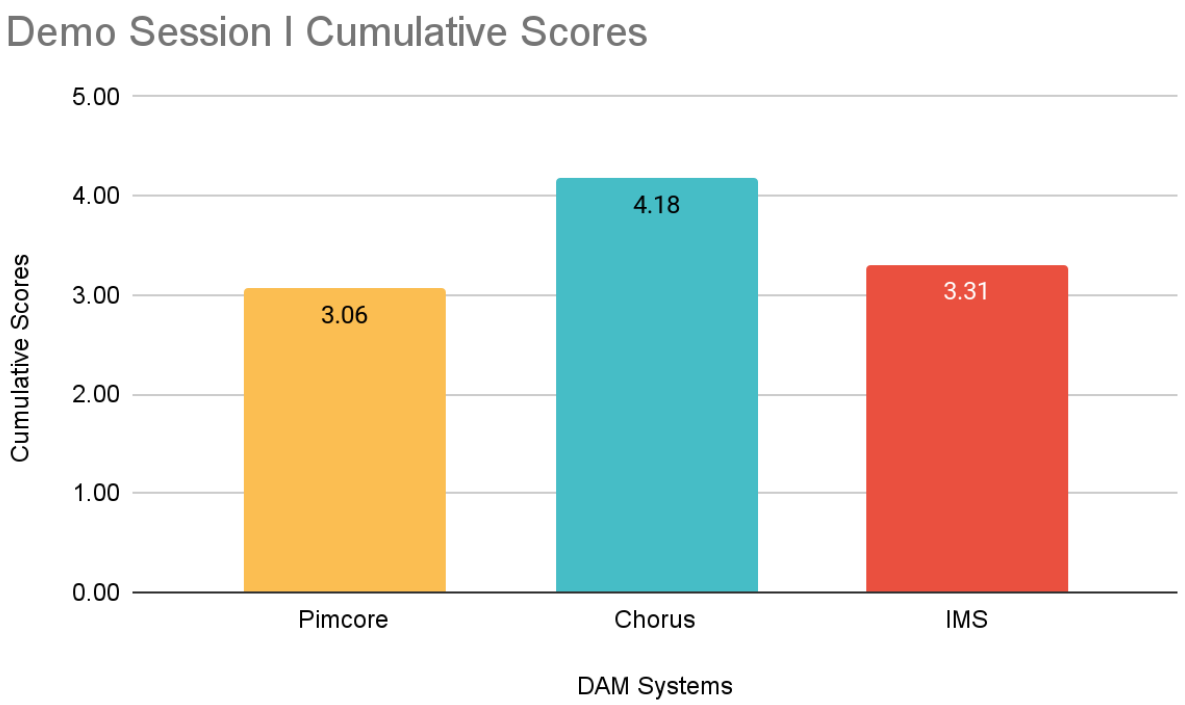

Figure 5: Cumulative Scores for each system in demo session I assessed by eight staff members.

Demo session II - testing preservation systems

Staff tested digital preservation systems for demo session II, instead of DAM systems like in demo session I. Demo session II consisted of three systems, Preservica, LIBSAFE Go, and Islandora. Similarly to demo session I, tasks that staff completed during the demos focused on the UI of each system and the upload and download process. In our data analysis, the user interface consisted of two sections: appearance and usability.

Quantitative rankings

In terms of appearance and usability, Preservica received the highest rating by museum staff with an appearance score of 4.13 ± 0.5, and a usability score of 4.25 ± 0.5. Islandora scored higher than LIBSAFE Go on appearance with a score of 2.5 ± 0.5 compared to 2.4 ± 0.5. However, LIBSAFE Go scored higher than Islandora on usability with a unanimous score of 2.75, compared to Islandora's score of 2.5 ± 0.5. This suggests that although Islandora had a cleaner, more organised user interface, staff members could navigate and operate LIBSAFE Go with greater ease. Generally, the staff considered UI usability a higher priority than UI appearance. See Figure 6 for more details on the appearance and usability comparisons. The vertical axis represents the staff's assigned rankings from one to five, and the horizontal axis contains the names of each system. Higher numbers are better.

In terms of the ability to upload and download content, Preservica received the highest score again, with an upload score of 4.63 ± 0.4 and a download score of 4.38 ± 0.5. Preservica had ease of use similar to a DAM, which was praised by the museum staff. There were many input fields for an asset upload, but not so many as to overwhelm the user. Islandora received criticism for the overwhelming metadata options, as well as the fact that uploading a single image was a multistep process where a repository item needed to be created before the image was uploaded. Islandora's score of 2.38 ± 0.5 and 3.88 ± 0.7 reflects this criticism. See Figure 7 for more details on the upload and download comparisons between systems. The vertical axis represents the staff's assigned rankings from one to five, and the horizontal axis names each system. Higher numbers are better.

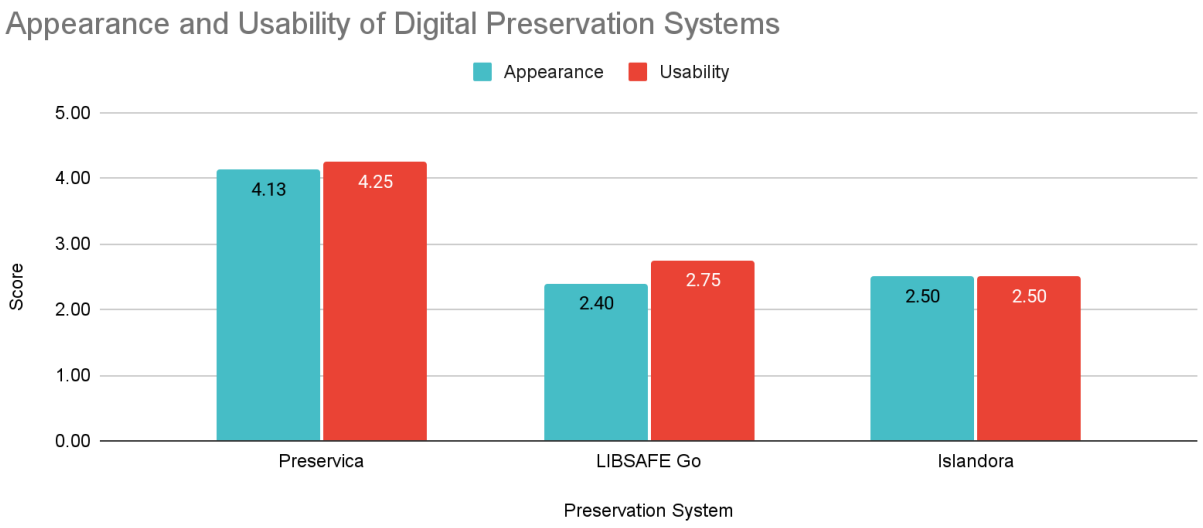

Figure 6: Average appearance and usability of different preservation systems from one to five according to eight museum staff members.

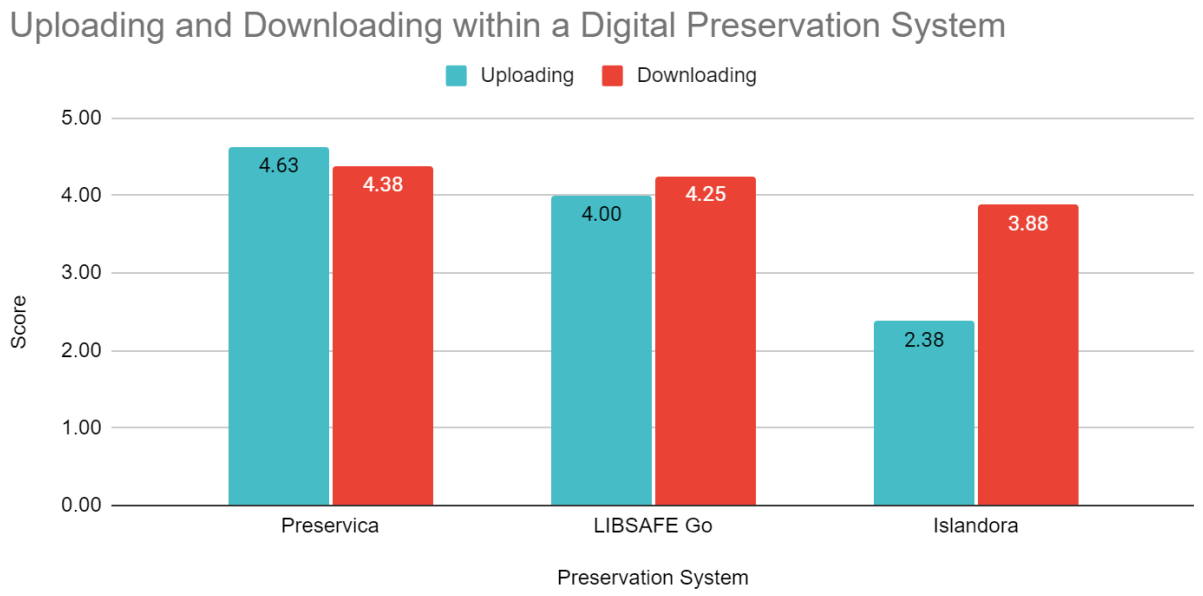

Figure 7: Average uploading and downloading ease of use of different preservation systems from one to five according to eight museum staff members.

Qualitative analysis

The most popular digital preservation system among participants was Preservica. Participants described the UI of Preservica as highly intuitive and easy to use when performing tasks. One participant described their user experience as "slick and smooth." Two participants, however, disliked how the system presented the preservation process. The participants said it was hard to tell if the system was running a proper ingest process and if an error were to occur in a step of the process, it would be difficult for users to identify where the error occurred. Participants enjoyed LIBSAFE Go's analytical data and appreciated the similar UI to Windows' File Explorer when exploring content. The most common complaint when using LIBSAFE Go, among participants, was the appearance and interface of the system, as it was hard to navigate. Participants also found the containers feature of the system (how the system organised digital assets) to be unintuitive. Participants found Islandora to be comprehensive and enjoyed how the system presented the metadata information, but they disliked the UI of the system as they found it hard to navigate and perform basic tasks such as uploading. See Appendix L for UI screenshots from Preservica and Islandora. We could not include a screenshot of LIBSAFE Go's UI due to a confidentiality agreement.

Cumulative scores

We summed and averaged the quantitative data for each Preservation system to generate an overview of which systems performed best. This was a compilation of the scores relating to uploading, downloading, appearance, and usability. We used these scores as a comparative, overarching assessment of each system. Preservica was the most well-received system, with the highest average score of 4.34, with notably excellent scores in the appearance and usability of the user interface. LIBSAFE Go came in second with a score of 3.37, because of the robust preservation features it offers, familiar Windows-like UI, and excellent uploading and downloading features. Pimcore scored the lowest with a score of 3.00, highly attributable to the complicated upload process and difficult to navigate UI. See Figure 8 for more details on the cumulative scores. The vertical axis represents the staff's assigned rankings from one to five, and the horizontal axis contains each system. Higher numbers are better.

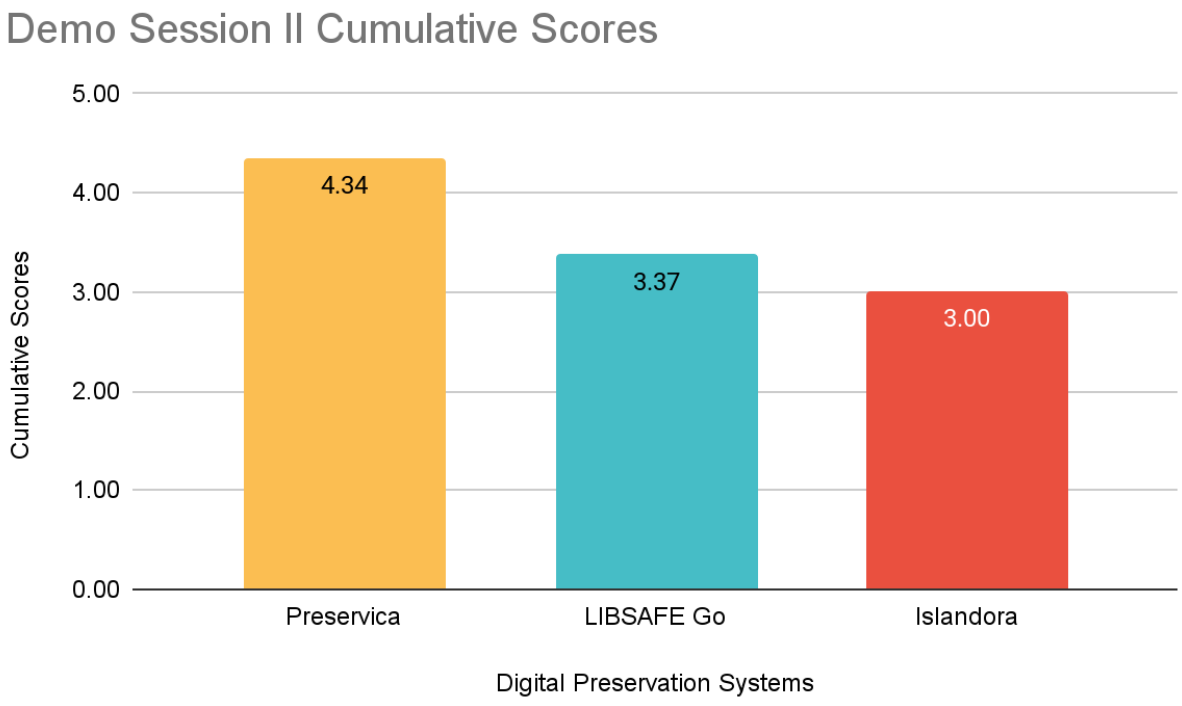

Figure 8: Cumulative scores for each system in demo session II assessed by eight staff members.

Orange Logic's Cortex

We also considered Orange Logic's Cortex as a combined solution (DAM and digital preservation system), but we were unable to have staff test the software. Because staff were never able to test the software, they were unable to give it the same level of scrutiny as other systems. In the end, Orange Logic became uninterested in our study and only focused on selling the product to The Postal Museum, not following through to make demo accounts for The Postal Museum staff. We sent other vendors a list of users from The Postal Museum staff, and they created accounts in demo software for us to use in our demo sessions. This was our original plan with Orange Logic, but their lack of communication made that goal unachievable.

Independent analysis

After completing our methods for the independent testing of each of the five available systems, we compiled our findings to compare the systems' performance in four areas. These areas are login time, search time, file upload time, and readability indexing. Note once again that

we could not test Islandora or Orange Logic's Cortex due to the demo sites being unavailable. To condense our comparisons, we grouped login times and search times together, collectively referred to as Page Response times. These results should not be misconstrued as a comprehensive analysis of each system's functionality, as they only test loading times and other technical attributes of the demo versions of each system. Making a conclusion on any given system's superiority solely from the following results would be impractical. For this reason, we used the results from this section as complementary data to our findings from interviews, demo sessions, and the focus group. Refer to the Conclusion and recommendations section for more information on how these results factored into the final system recommendations.

Page response times

LIBSAFE Go was the clear winner with login time, coming in at an average of 0.5 seconds after ten tests of the login process. Chorus had the fastest average search time of 0.88 seconds, again after ten tests of the search timing process. Figure 9, seen below, displays each system's login time next to its search time, with login times coloured in blue and search times coloured in red. The units for time are in seconds, on the vertical axis, and the horizontal axis contains each respective system name. Lower numbers are better.

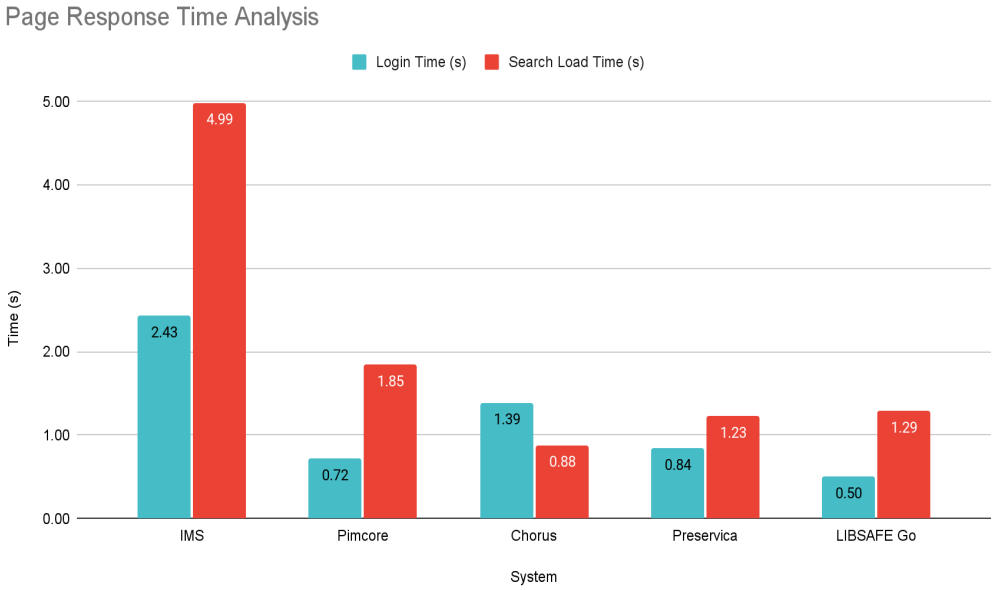

Figure 9: Page response times for login and search times measured by Selenium and Python.

Upload times

Preservica and LIBSAFE Go had the fastest upload times at 1.47 seconds, with Pimcore close behind at 1.16 seconds. Chorus was the slowest in terms of upload times, with an average speed of 3.34 seconds. See Figure 10 for each system's upload times. The units for time are in seconds, on the vertical axis, and the horizontal axis contains each respective system name. Lower numbers are better.

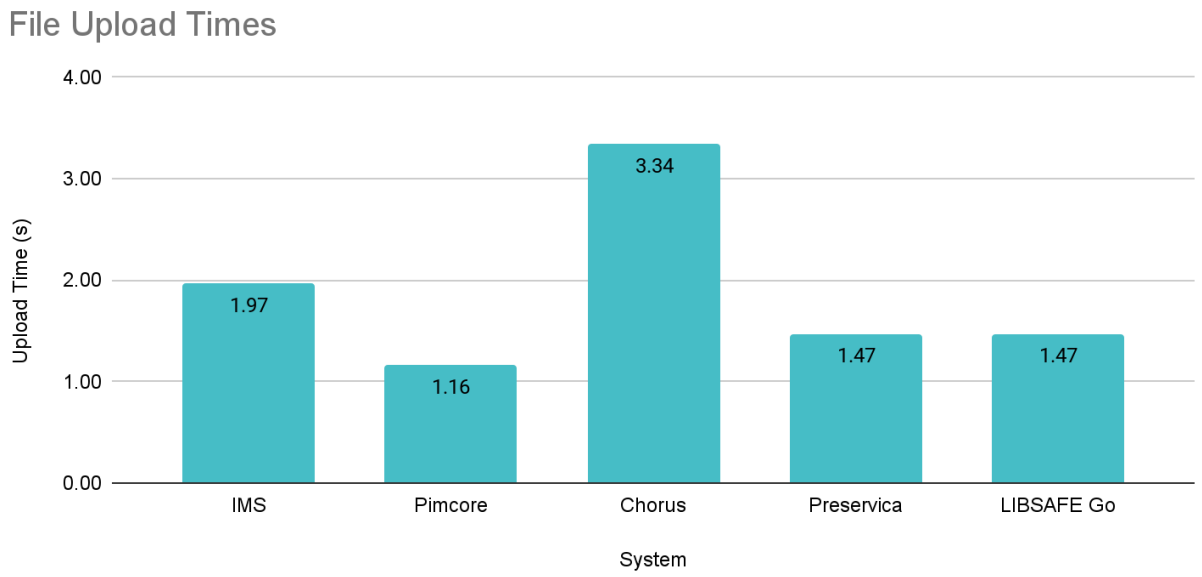

Figure 10: File upload time measured by Selenium and Python starting when the file upload dialogue is captured.

Readability indexing

We analysed the readability of each system's textual elements by comparing the contrast between the background and the text, as well as comparing font choice. Higher contrast generally means better readability; the below graphs with higher contrast values suggest a better UI design. Similarly, good choices for font type mean improved readability, and the below section describes best practices for font choice.

Contrast

Preservica had the highest relative contrast ratio at 0.95, while Chorus came in at a close second at 0.94. Chorus and Preservica both use black text on a white background in most areas of the UI, leading to these high contrast scores. IMS scored lower because the background wasn't completely white, while the text was grey or black. Pimcore scored the lowest for readability because the colour scheme often placed white text on a darker colour background, which can cause the text to be difficult to read. See Figure 11 for contrast results. The vertical axis represents relative contrast, and the horizontal axis contains each respective system name. Higher numbers are better.

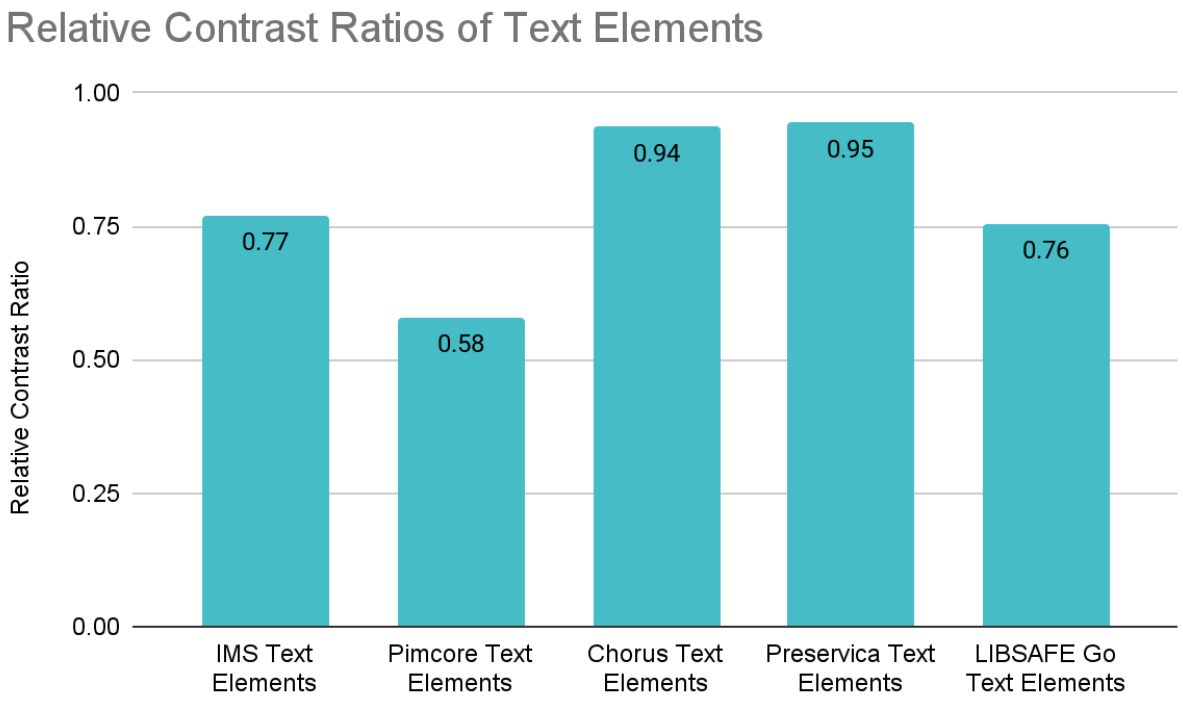

Figure 11: Graph showing the relative contrast ratios of the text to the background of various elements within each DAM system and digital preservation system.

Font choice

We measured the font size in the navigation interface and determined that IMS and Preservica generally use the largest font size, followed by Pimcore and Chorus. Chorus would benefit by increasing the size of its text and slightly reducing the whitespace on the page.

Ultimately, the font in each system is readable enough that it was not a determining factor in driving our recommendation. See Table 2 for font analysis results.

System	Font Style	Example Sentence	Font Size
Chorus	Source Sans Pro	The quick brown fox jumped over the lazy dog	11px
IMS	Arial	The quick brown fox jumped over the lazy dog	16px
Pimcore	Open Sans	The quick brown fox jumped over the lazy dog	13px
Preservica	Poppins	The quick brown fox jumped over the lazy dog	16px
LIBSAFE Go	Roboto	The quick brown fox jumped over the lazy dog	13px

Table 2: Font comparisons for different DAM systems and digital preservation systems

Focus group

We discussed difficulties staff were having with IMS during the focus group. Staff members had difficulty completing bulk uploads and including metadata within those bulk uploads. Staff wanted a way to have quality control on the uploads to avoid low-quality images within the system. For downloading, staff appreciated the drop-down list of formats, but others did not know what the different download formats meant. All these comments built on the theme that IMS is not a user-friendly software and could be replaced by software where site actions are easier to access and understand.

The group discussed Chorus and Pimcore as alternatives to IMS and generally favoured Chorus due to its visually rich, intuitive, and clean user interface. The group felt that Chorus was easy to navigate and did not present unnecessary options to the user at any given time. Pimcore, on the other hand, was overwhelming with the number of options presented to the user, according to staff. Additionally, the group thought that Pimcore's text-based approach to

interacting with the user interface was inferior to Chorus's image-based approach. Chorus places thumbnails and image previews front and centre within its UI, while Pimcore requires the user to navigate a file-based hierarchy before seeing image previews.

In terms of preservation systems, the group favoured Preservica for its simple DAM-like user interface. The longest point of discussion was cloud vs local storage options. From a security standpoint, the group was concerned about confidential documents being stored in the cloud on servers owned by another company. As a counterpoint, someone stated that many companies that use Preservica store confidential documents, and therefore trust the cloud configuration. In the case that the group wants more control over documents, Islandora would make sense, given it uses Archivematica as a backend and can be operated locally within the museum. On the other hand, if the staff wants a more practical, future-proof approach, Preservica tends to be the favoured cloud option.

Conclusion and recommendations

Memory institutions, such as museums and libraries, have served the important societal purpose of preserving knowledge for thousands of years. Starting from analogue sources such as scrolls and books to the modern-day digital environment of images, PDFs, and other digital assets, institutions have continuously faced the challenge of preserving large volumes of data. Today, there are many options to preserve and organise media within Digital Asset Management (DAM) systems and digital preservation systems, each with their own advantages and disadvantages. The Postal Museum uses one such DAM system to preserve the rich postal history of Britain with collections ranging from books and stamps to maps and posters. The Postal Museum is interested in upgrading its current DAM system, IMS, because it has become disorganised and difficult to use.

Our first step in finding suitable systems for The Postal Museum was to create a short list of potential system options. We spoke with museum staff, researched systems online, and reviewed company marketing material. After selecting our list of system candidates, we interviewed staff at The Postal Museum to gather their opinions on their current DAM system and learn about features or improvements they desired in a new system. We then tested demo versions of each system with staff to gather their opinions on each system's design and features. Following these demos, we invited all participating staff to a focus group, where we reviewed each system and encouraged staff to discuss their opinions about each system. We also evaluated each system as a team using objective measures such as login time to contribute to our recommendation.

The preliminary interviews revealed that metadata, tagging, and uploading processes need to be improved. The interviews also revealed the practicality of the sharing features of IMS, the desire for UK-based customer support, and the benefits and drawbacks of cloud vs local storage. The interviews also made clear that The Postal Museum would benefit most from both a new DAM and digital preservation system. The demo sessions revealed that the most common desired feature was an intuitive user interface. If the interface is easy to navigate, responsive, and visually appealing, staff are more likely to complete their tasks much faster. Specifically for the

preservation systems, the staff wanted ease of use similar to a DAM, where extra features were hidden from view unless necessary. The focus group echoed these thoughts where the group appreciated being able to achieve tasks in each system with as few clicks as possible. We took these considerations into account when choosing a final recommendation for a new system, alongside all the responses we received from staff in post-demo surveys. Our objective analyses showed that the systems that staff thought had the best appearances and usability also had strong page response times and file upload times. Based on our findings, we compiled all the prospective systems into a hierarchical table which ranks both DAM and digital preservation systems independently. In the following sections, we suggest optimal system configurations that would best fit The Postal Museum's needs, new practices to improve data organisation, and next steps for the museum and other researchers. Our system configuration recommendations consist of an optimal solution, an all-in-one option, an open-source option, and an additional alternative option. See Table 3 for our system rankings.

Rankings (DAM)	DAM	Cumulative Score	Cost Estimate (annually)
#1	Chorus	4.18	£1,200
#2	Pimcore	3.06	£20,000
#3	IMS	3.31	£1,200
Rankings (Preservation)	Preservation Systems	Cumulative Score	Cost Estimate (annually)
#1	Preservica	4.33	£20,000
#2	LIBSAFE Go	3.37	£15,000
#3	Islandora	3.00	£1,000
Rankings (Hybrid)	System	Cumulative Score	Cost Estimate (annually)
#1	Orange Logic's Cortex	N/A	£30,000 – £60,000

Table 3: Rankings of DAM systems and Preservation systems

Chorus and Preservica: optimal system configuration

Based on our findings, Chorus and Preservica is the best setup for The Postal Museum's needs. Chorus satisfies requests from staff for an intuitive, fast, and visually appealing user interface. Chorus scored well in user interface appearance and user interface navigability, which was a key concern for staff members who frequently utilise the current DAM system. Chorus scored very well in our independent analysis (see "Independent analysis" section within the Results and analysis chapter). Chorus also has robust permission-allocation features that will allow The Postal Museum to standardise metadata entry for their digital assets, allowing for improved organisation within the system. Lastly, Chorus is the most affordable amongst our DAM system candidates, with a price of about £1,200 per year. This price point further bolsters Chorus' merit as a DAM solution for the museum. Preservica is our recommendation for a digital preservation system to go along with Chorus. Preservica offers OAIS ISO 14721 compliant preservation capabilities that will ensure The Postal Museum's prized digital assets will be maintained for decades to come. Preservica scored the highest in post-demo survey questions, beating LIBSAFE GO and Islandora in every section.

Orange Logic's Cortex: an all-in-one solution

The preliminary interviews made it clear that staff at The Postal Museum value a clean, intuitive user interface. Overall, simplicity is key to The Postal Museum's future success. We recommend Orange Logic's Cortex system as an all-in-one solution to act as both the DAM system and digital preservation system for The Postal Museum. This alternative eliminates the need for two separate systems which simplifies implementation and would lead to easier daily use once operational. Cortex scored highly in the post-demo surveys, specifically with site appearance and sharing features. Cortex fulfilled the needs of the museum with an OAIS-compliant digital preservation offering, as well as a feature-rich DAM solution. Additionally, Orange Logic has a satellite support office in Oxford, England which can provide active customer support to The Postal Museum. The largest concern for Cortex is the steep price point. The Orange Logic team offered to implement nearly every feature requested by The Postal Museum staff, but their pricing is targeted toward larger enterprise users, meaning it is significantly more expensive than other DAM or digital preservation offerings. We estimate the

price for this system would be between £30,000 - £60,000 per year given The Postal Museum's needs. The larger clientele of Orange Logic like Reuters and the BBC benefit from the highly customizable feature set offered by Cortex while being able to easily afford the expensive price point. Therefore, a smaller-scale product would be better suited for The Postal Museum.

Open-source solution

We recommend Pimcore as an alternative DAM system to Chorus. Pimcore is not a top choice due to its poor performance during demo session I, but it was rated the second-highest for its sharing and downloading features which were important to staff. Additionally, Pimcore had the fastest search times and third fastest login times. Pimcore also has an Iceland office within the same time zone as The Postal Museum, which would be helpful for customer support. In conjunction with Pimcore, we recommend the staff use Islandora as an alternative digital preservation system to Preservica. This system configuration would be an open-source solution where the main benefits are the high levels of customizability that open-source solutions allow. Both Pimcore and Islandora scored the lowest in terms of post-demo surveys, which is likely attributable to the unintuitive UI the systems use to show all the possible user-customizable features they support. One disadvantage with open-source solutions is that their implementation would likely be more time-consuming than the other solutions, as The Postal Museum would need to spend time modifying the open-source code to satisfy their feature requirements. The end product, however, would be a customised solution that fits The Postal Museum's needs, possibly more so than other commercial systems.

LIBSAFE Go: an alternative to Preservica

We recommend LIBSAFE Go as an alternative to Preservica, because both offer similar preservation features (safety of outdated file types, geographical distribution of data), but demo participants found Preservica's DAM-system-like user interface easier to use. LIBSAFE Go scored well during demo session II in terms of preservation features and usability, and The Postal Museum staff had moderate difficulty navigating the container-based file structure of the system. Participants enjoyed the familiar file explorer interface when browsing through the digital assets, but some felt that the design could be more intuitive and modern to improve ease of use.

Recommendation for standardising the upload process

Regardless of the system configuration The Postal Museum selects, our research revealed that the success of any configuration depends on strong organisational practices. Therefore, an additional recommendation we have for The Postal Museum is for them to implement new standards for file uploading, including training sessions for all relevant members of The Postal Museum staff that describe how to take advantage of the features the system provides. Different departments may require different metadata schemas for each upload, so the training sessions should be organised by department. The goal of this recommendation is to standardise the metadata entry process of uploading a new asset. For example, a description, alternative text, copyright information, creation date, and collections reference number should be required with all new uploads. Staff could also choose to utilise a metadata standard such as Dublin Core for all of their newly uploaded preservation files. We suggest that staff leaders formulate a plan to better organise file hierarchies, ensuring that all files are in a folder that pertains to their subject, avoiding cluttering of the system. The implementation of a new system will make metadata entry easier than in IMS, and proper staff training will allow the system to be easily searchable and user-friendly. Standardising the metadata included with new uploads, as well as organising file hierarchy, will be vital to keeping a new DAM and digital preservation systems usable and organised in the long term.

Next steps

The implementation process for The Postal Museum's choice of a new system configuration falls out of the scope of this project. Implementation will likely be a lengthy process, as files need to be transferred from the current system, IMS, as well as shared drives within The Postal Museum's network infrastructure. Additionally, many files need to be "cleaned," or have their metadata properly reclassified before being moved, preventing organisational problems from being carried along to the new system. Chorus offers customer support to assist with the implementation process, and we recommend that staff utilise this resource to help with the transition, should they choose the system. Additionally, we suggest that The Postal Museum consider contacting another research team, possibly another IQP team from WPI, to assist with the implementation process. Furthermore, we have ensured that each system

vendor included in our final recommendation section has adequate contact information for staff at The Postal Museum, to avoid a lack of contact.

Strategies for identifying an optimal system configuration

We developed a six-step process for selecting a DAM and digital preservation system configuration that is specifically tailored to an institution's situation. Therefore, we recommend future researchers working in the same realm use similar methods to ours to determine which system best fits their client's needs. However, that is not to say that our methods are beyond reproach. We suggest researchers assess their client's needs and assign rankings for the client's desired feature sets. Additionally, we recommend researchers invest the time in trying each software (i.e., demos), as this method is the best way to experience the system's intricacies and develop a better understanding of each feature. We encourage researchers to reach out to system vendors as soon as possible, as the process of acquiring demo software for each system in our study was time-consuming. We suggest that researchers work closely with primary users of the system and members of IT staff at their institution, as we found that staff who interact with and know the most about the entire system configuration have the most valuable insight into choosing a new one. Other staff members who may not be as technically knowledgeable or are not as familiar with the system's use are still relevant to the study, but their opinions will likely be focused on the usability and workflow offerings of each system. Lastly, we recommend researchers study other successful memory institutions, considering their asset management practices, and looking into the systems they employ. This strategy allows researchers to design practices and employ workflows specifically tailored to the needs of their clients.

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Appendices

Appendix A: ISAD (G) archival description

The General International Standard Archival Description (ISAD (G)) is a preservation standard that was first published in 1994 by the International Council on Archives. The goal of this standard was to introduce a similar level of organisation as seen in traditional archival media such as paper and parchment (Shepherd & Smith, 2000). As more projects related to the automation of archival repositories began in the 1980s, archivists discovered the need for consistency in digital archival description. Additionally, creating a standard for archival description would allow institutions in different geographical locations to share data with one another seamlessly. Museums and Institutions use ISAD (G) by collecting the fonds, which are all of the documents, regardless of type, that are to be organised. Next, the fonds can be broken down into subfonds, which can be broken down into series, then files, and finally individual items. Although this is likely a common hierarchical structure for organising one's assets, the ISAD (G) standard allows for the user to choose as many or as few levels of stratification as they see fit, and the naming of each level is subject to change. Although, there are additional rules defined in the standard that are less flexible. One rule calls for the description of items from the general to the specific. For example, the description of the fonds should be general information about all of the items in the fonds, while the description of one folder would be specific to just its contents. On the same note, the standard states that any descriptive information should be solely related to the given level of description. For instance, granular details are not necessary for the fonds, and overarching details should not be mentioned in an individual folder. Another important feature of the multilevel description should be the clear relationship of hierarchical position between each level. Linking each folder to its respective higher-level series, for example, is required. Finally, the non-repetition of information is essential to a successful multilevel descriptive setup under the ISAD (G). Avoiding the reiteration of information within a lower-level file that has already been detailed at a higher level is optimal for strong organisation (Stibbe, 1998).

Appendix B: OAIS and ISO

An OAIS is designed for the long-term, meaning that it must take into account changing file formats, and provides support for newly introduced media types. Another goal of the system is that the audience, referred to as the "Designated Community," has a complete understanding of the digital assets that they are managing, to prevent the need for external assistance. The ISO OAIS is a reference model for an OAIS. A reference model is a collection of the most important concepts in the given field, put together in a way that allows for the explanation of the standard to someone who is unfamiliar. The model would include definitions of terminology, relevant concepts, as well as a framework for comparing preservation standards. Together, these pieces of information aim to make digital preservation easy to understand for the uninitiated user, and more importantly easy to replicate and implement to ensure active use of the standard (Lee, 2010). The specific reference model put forth by the ISO is called ISO 14721:2012. The ISO makes it clear that their OAIS can be used by any archival system, both physical and digital, but it is specifically tailored to be used by institutions looking to preserve their information for the long-term (International Organisation for Standardisation, 2018).

Appendix C: Department requests for system features

Purpose statement

This table includes features for both DAM systems and digital preservation systems that staff at The Postal Museum expressed interest in. The brief feature description is accompanied by the corresponding department(s) who desired the feature. Our team utilised this table to share with software vendors to provide context for the museum staff's workflow. Sharing this table allowed vendors to provide customised demo sites that better fit the staff's needs.

Feature table

Feature	Department
Robust search tool (fast, accurate, filtering)	Archives
Easy to share content (primarily with 3rd parties)	Archives / PR and Social Media
Ensured authenticity of files	Archives
High-quality images	Archives
Responsive customer service	IT
Categorization of assets	IT
Multi file format support (HTML, Videos, 3D models, scans, HEIC)	IT
Scalability (storage)	IT
Related files automatically shown	IT/Archives
Level 4 digital preservation (NDSA)	Archives
"Away from desk" uploading	Photography
Image Crowdsourcing (public uploads, mobile app offering)	Photography
Image Editing Features	Photography
Auto-Generated backups/shadow files	Photography
Configurable permissions for uploading (per user)	PR and Social Media
Customizable metadata schemas when uploading images	PR and Social Media
Granular search filters (black and white, colour)	PR and Social Media
Public access (image licensing, purchase)	Photography

Appendix D: Preliminary staff interview questions

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts and we are working with The Postal Museum in London, England to provide a recommendation for a new DAM system and digital preservation system to The Postal Museum. Currently, we are conducting a series of interviews, facilitating demo sessions, and planning a focus group with the museum staff to better understand each department's needs for their new DAM system and digital preservation system, and the reasons that lead to the disorganisation of their current DAM system.

Your participation in these discussions is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will be transcribed or appear on any of the project reports or publications. Our team will use this information to aid the museum staff in selecting a new system or systems.

If interested, a copy of our results can be provided through an internet link at the conclusion of the study. Your participation is greatly appreciated.

Purpose statement

We conducted preliminary staff interviews early in our stay in London to gather information about The Postal Museum's current system, and their needs for a replacement. Questions that we asked staff at The Postal Museum to gather information include:

Interview questions

- What aspects of the current system do you dislike?
- What tagging practices are common amongst staff?
- What practices do you believe led to the disorganisation of the current system?
- What features are most important for you in the new system?
- Do you desire sharing features for the new system?
- What is the price range for the implementation of a new system?
- What features would be nice to have in a new system, but are not essential?

Appendix E: Review software vendor marketing material

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts and we are working with The Postal Museum in London, England to provide a recommendation for a new DAM system and digital preservation system to The Postal Museum. Currently, we are conducting a series of interviews, facilitating demo sessions, and planning a focus group with the museum staff to better understand each department's needs for their new DAM system and digital preservation system, and the reasons that lead to the disorganisation of their current DAM system.

Your participation in these discussions is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will be transcribed or appear on any of the project reports or publications. Our team will use this information to aid the museum staff in selecting a new system or systems.

If interested, a copy of our results can be provided through an internet link at the conclusion of the study. Your participation is greatly appreciated.

Purpose statement

We analysed the marketing material of each DAM system or digital preservation candidate in order to gather information about the company that provides the service, including what features they deem to be most important. This allowed us to gather information about each system's features and eliminate offerings that lack features needed by The Postal Museum staff. Questions that we considered when analysing each offering include:

Analysis questions

- What scale does the company market their system for?
    - What type of volume can the system be expected to manage?
    - How much traffic can the system manage?
    - Does the company offer different tiers for different volumes of data?
- What support does the company offer for the system?
    - Is 24/7 technical support offered?

    - Does the company offer to help with setup?
    - Does the company offer to help with migration?
- How does the company differentiate itself from the competition?
    - Does the company offer different features than the competition?
    - Is there a competitive price advantage?
    - Does the company offer customization options?

Appendix F: Demo tasks

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts and we are working with The Postal Museum in London, England to provide a recommendation for a new DAM system and digital preservation system for The Postal Museum. Currently, we are conducting a series of interviews, facilitating demo sessions, and planning a focus group with the museum staff to better understand each department's needs for their new DAM system and digital preservation system, and the reasons that lead to the disorganisation of their current DAM system.

Your participation in these discussions is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will be transcribed or appear on any of the project reports or publications. Our team will use this information to aid the museum staff in selecting a new system or systems.

If interested, a copy of our results can be provided through an internet link at the conclusion of the study. Your participation is greatly appreciated.

Purpose statement

We created a series of tasks for participants to follow as they tested DAM system and digital preservation system candidates. The purpose of the tasks was to test actions that are commonly performed by the staff with their current system to learn how the new system performs in comparison. We observed participants as they completed these tasks and encouraged participants to verbalise their decisions and actions as they complete each task, a method known as *Think-aloud*. Example tasks and *Think-aloud* details can be seen below.

Demo tasks

- Find an image based on specific tags
- Upload an image and tag it accordingly
- Find the settings menu within the user interface
- Share an image from the database to an external source
- Download an image to local storage from cloud storage

Think-aloud procedure

Developing the setup for the system demos is the first step to successfully using the *think-aloud* method. Nielsen (2000) suggests that five participants are enough, and after the number of participants is identified, the tasks should be created. Our sessions were with one participant only, so this may be a limitation with our use of this method. Tasks included step-by-step instructions, as well as reminders for participants to voice their feelings along the way. We provided participants with in-depth details including a description of the purpose of this method and asked each participant for consent prior to beginning the demos. We asked each participant to complete tasks and then asked follow-up questions throughout to continue receiving input from the participant. We took notes on the participant's thoughts during the demo and collated these findings afterwards in order to compare each system.

Appendix G: Post-demo survey questions

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts and we are working with The Postal Museum in London, England to provide a recommendation for a new DAM system and digital preservation system to The Postal Museum. Currently, we are conducting a series of interviews, facilitating demo sessions, and planning a focus group with the museum staff to better understand each department's needs for their new DAM system and digital preservation system, and the reasons that lead to the disorganisation of their current DAM system.

Your participation in these discussions is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will be transcribed or appear on any of the project reports or publications. Our team will use this information to aid the museum staff in selecting a new system or systems.

If interested, a copy of our results can be provided through an internet link at the conclusion of the study. Your participation is greatly appreciated.

Purpose statement

We utilised post-demo surveys to gather information on the user's experiences for each DAM system or digital preservation system demo. These surveys complemented our data gathering during the actual demo and allowed us to gather crucial data about participants' thoughts and opinions on each system. Certain questions were accompanied by a qualitative scalar ranking to better gauge how staff perceive system features. We asked staff to provide both a descriptive answer to these questions and a ranking of the feature from 1-5. These rankings allowed us to compare each system's performance after testing was complete. Questions with this additional metric are marked below. Survey questions included:

Survey questions

- What was one thing you enjoyed about the system?
- What was one thing you disliked about the system?

- Were there any features that you thought were better than their counterparts in the current system?
- Were there any features that you thought were worse than their counterparts in the current system?
- How easy was it to find a given image based on provided tags? (also rate 1-5)
- How did you value the sharing capability present in this system? (also rate 1-5)
- How easy was it to navigate the system's user interface to find specified features? (also rate 1-5)
- How easy was it to upload images and tag them? (also rate 1-5)
- How easy was it to download images from cloud storage? (also rate 1-5)
- How would you rate the user interface in terms of usability? (also rate 1-5)
- How would you rate the user interface in terms of appearance? (also rate 1-5)

Appendix H: Focus group

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts and we are working with The Postal Museum in London, England to provide a recommendation for a new DAM system and digital preservation system for The Postal Museum. Currently, we are conducting a series of interviews, facilitating demo sessions, and planning a focus group with the museum staff to better understand each department's needs for their new DAM system and digital preservation system, and the reasons that lead to the disorganisation of their current DAM system.

Your participation in these discussions is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will be transcribed or appear on any of the project reports or publications. Our team will use this information to aid the museum staff in selecting a new system or systems.

If interested, a copy of our results can be provided through an internet link at the conclusion of the study. Your participation is greatly appreciated.

Purpose statement

We facilitated a focus group consisting of members from each department of The Postal Museum who interact with the DAM system in their work. By presenting the group with a series of informal discussion questions, we gathered recurring opinions and concerns about the current DAM system and the new DAM or digital preservation system amongst the staff. The overall goal of this method was to reveal connections that otherwise disparate departments have with one another, and to collect the most frequently occurring opinions, desires and thoughts regarding new systems. Discussion questions that will be presented to the group can be seen below.

Discussion questions

- What were some general thoughts on the systems tested?
- What feature(s) stood out?
- What tasks were especially hard to perform?

- Do you see yourselves using any of these systems in the future?
- What is one system that you particularly enjoyed?
- What is one system that you particularly disliked?

Appendix I: Response time code

Purpose statement

This code runs through the login and search functions of a database website and measures the time for each.

```
from selenium import webdriver
from selenium.webdriver.common.keys import Keys
from time import sleep
import time

from selenium.common.exceptions import TimeoutException
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from selenium.webdriver.common.by import By


# load the webdriver as firefox
driver = webdriver.Firefox()
driver.get('https://postalmuseum.chorus.thirdlight.com/')
sleep(7)

# Get the username/password elements and submit the login form
username =
driver.find_element_by_xpath('/html/body/div/div[1]/div/div[2]/form/div[2]/div[1]/input[1]')
password =
driver.find_element_by_xpath('/html/body/div/div[1]/div/div[2]/form/div[2]/div[1]/input[2]')
username.send_keys("username")
password.send_keys("password")
driver.find_element_by_xpath("/html/body/div/div[1]/div/div[2]/form/div[2]/div[3]/div[1]/span").click
()

#Time how long it takes to login
prevTime = time.time()
timeout = 10
try:
   element_present = EC.presence_of_element_located((By.XPATH,
'/html/body/div/div[1]/div/div[1]/div[2]/div[4]/div/div[2]/form/input'))
   WebDriverWait(driver, timeout).until(element_present)
except TimeoutException:
   print("Timed out waiting for page to load")
   exit()

timeDifference = time.time() - prevTime
print("Login Load time: {}ms".format(timeDifference))

#Wait for the page to load
```

```
sleep(10)

#Find the searchbar
searchbar =
driver.find_element_by_xpath('/html/body/div/div[1]/div/div[1]/div[2]/div[4]/div/div[2]/form/input')
searchbar.send_keys("food")
searchbar.send_keys(Keys.ENTER)

#Time how long it takes to search
prevTime = time.time()
COFFEE_PIC_CSS_SEL = 'div.pinboard-assets:nth-child(1) > div:nth-child(1) > div:nth-child(1)'

try:
    element_present = EC.presence_of_element_located((By.CSS_SELECTOR,
COFFEE_PIC_CSS_SEL))
    WebDriverWait(driver, timeout).until(element_present)
except TimeoutException:
    print("Timed out waiting for page to load")
    exit()

timeDifference = time.time() - prevTime

print("Search Load time: {}ms\n".format(timeDifference))
#driver.close()
```

Appendix J: Contrast analysis code

Purpose statement

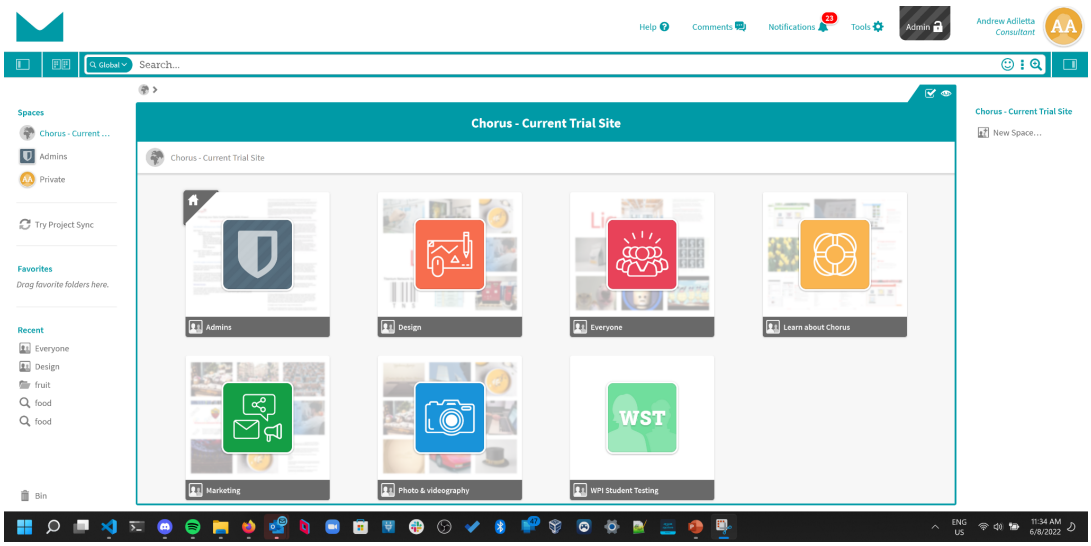
We used this code to determine the readability of an image of text, via its contrast, in our testing of various systems.

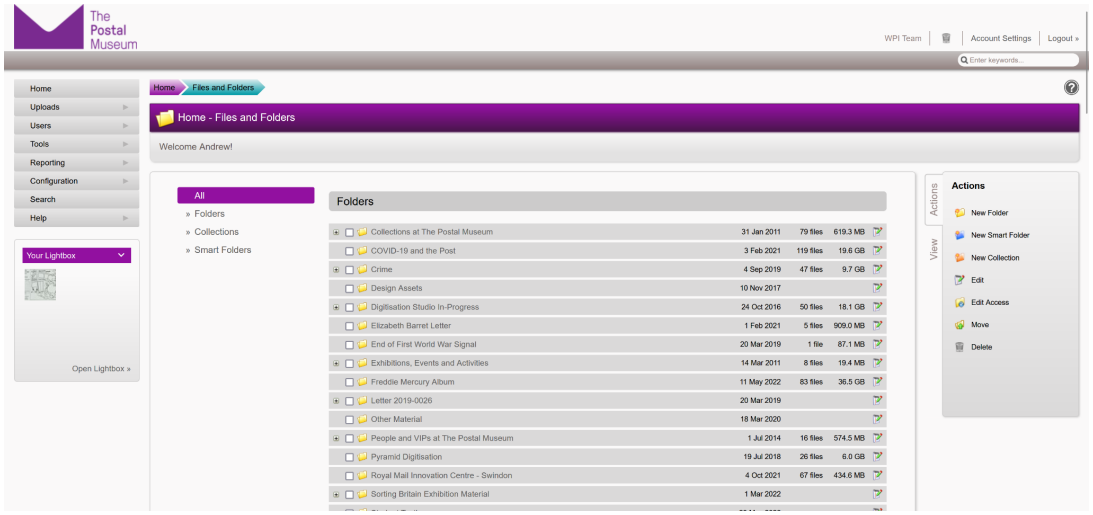
Code

```
# Average all the pixels in an image and return the average color
import math

FILE_NAME = "libsafe/image2.png"
BACKGROUND = "#000000"

#If the background is lighter than the text
LIGHTER = False
TOLERANCE = 50

# import Image
from PIL import Image

# Get all the pixels in an image
def get_pixels(image):
    pixels = []
    for x in range(image.width):
        for y in range(image.height):
            pixels.append(image.getpixel((x, y)))
    return pixels

#Open the image
image = Image.open(FILE_NAME)
myPixels = get_pixels(image)
total = [0, 0, 0]
pixel_number = 0

#split BACKGROUND into RGB
red_background = int(BACKGROUND[1:3], 16)
green_background = int(BACKGROUND[3:5], 16)
blue_background = int(BACKGROUND[5:7], 16)



for pixel in myPixels:
    if(LIGHTER and (pixel[0] >= red_background-TOLERANCE and pixel[1] >=
green_background-TOLERANCE  and pixel[2] >= blue_background-TOLERANCE)):
        pass
```

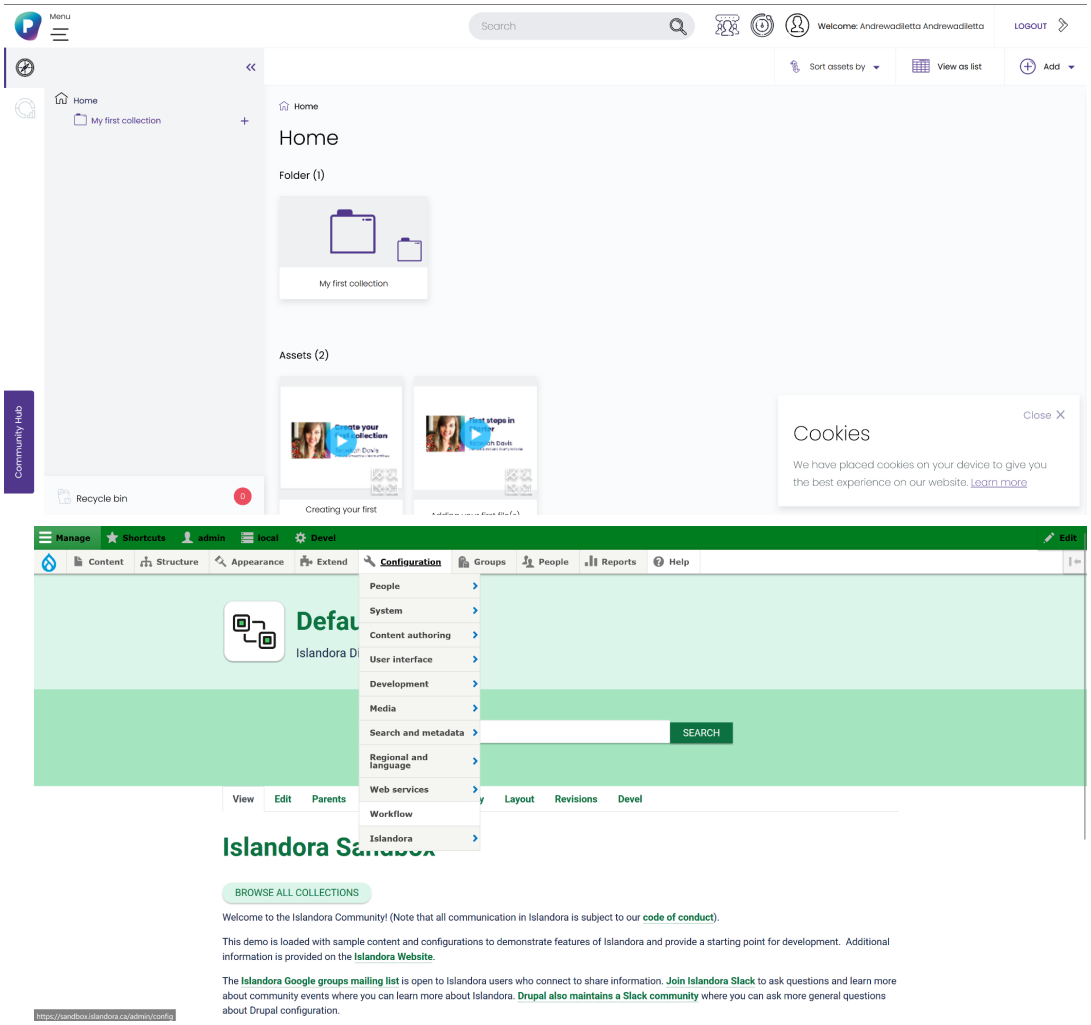
```
    elif(not LIGHTER and (pixel[0] <= red_background+TOLERANCE and pixel[1] <=
green_background+TOLERANCE  and pixel[2] <= blue_background+TOLERANCE)):
        #print(pixel)
        pass
    else:
       # print(pixel)
        total[0] += pixel[0]
        total[1] += pixel[1]
        total[2] += pixel[2]
        pixel_number += 1

total[0] = total[0] / pixel_number
total[1] = total[1] / pixel_number
total[2] = total[2] / pixel_number

luminance_background = (red_background*0.2126 + green_background*0.7152 +
blue_background*0.0722)/255.0
luminance_total = (total[0]*0.2126 + total[1]*0.7152 + total[2]*0.0722)/255.0

if LIGHTER:
    contrast = abs((luminance_total+0.05)-(luminance_background+0.05))
else:
    contrast = abs((luminance_background+0.05)-(luminance_total+0.05))

distance = 0
distance += red_background-total[0]
distance += green_background-total[1]
distance += blue_background-total[2]

distance = distance / 3

print("Average Color: #{}{}{}".format(hex(int(total[0]))[2:], hex(int(total[1]))[2:],
hex(int(total[2]))[2:]))
print("Contrast: {}".format(contrast))
```

Appendix K: Home screen of Pimcore, Chorus and IMS





Appendix L: Home screen of Preservica and Islandora



Screenshots for LIBSAFE Go's homepage could not be provided as we signed confidentiality agreement.