IDENTIFYING A COLLECTIONS MANAGEMENT SYSTEM FOR TOWER BRIDGE

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ABSTRACT

As a listed historic building and visitor attraction, Tower Bridge is in need of a centralized digital repository to better manage the assets used in its interpretation, educational activities, marketing, and operation. This project assisted Tower Bridge to identify and implement a searchable, scalable, Spectrum compliant, and secure collections management system (CMS), intended initially for internal use. Our group conducted key informant interviews, surveyed Tower Bridge staff, and used online resources to identify important criteria and options for a CMS. Using our findings on potential systems, Tower Bridge chose CollectionsIndex+. We provided recommendations and training videos for CollectionsIndex+, setting the foundation for future exhibitions and increased public engagement.

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- Dirk Bennett, Exhibition Development Manager

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TABLE OF CONTENTS

Abstract and Acknowledgements iii
List of Figures v
Introduction: A Centralized Repository for Tower Bridge 1
Background 3
- From Private Collections to Public Exhibitions: The History of Museums and Their Visitors 3
- Implementation of Digital Technology to Increase Public Engagement with Museums 6
- Databases in a Museum Context 9
- Identifying Options for Collections Management Systems 12
- Tower Bridge and Its Need for a Collections Management System 13

Methods 15
- Objective 1: Research potential Collections Management Systems 16
- Objective 2: Choose the system that best fits the needs of Tower Bridge 17
- Objective 3: Research the implementation of CollectionsIndex+ 18
- Objective 4: Develop User Training Videos 19

Findings from our Research 20
- Important Features for a Collections Management System at Tower Bridge 20
- Identifying and Filtering Out Systems that are Suitable for Tower Bridge 23
- Project Team's In-depth Analysis into Potential Systems 25
- Using Input from Tower Bridge Staff to Recommend a CMS 28
- Implementing CollectionsIndex+ for Tower Bridge 33

Concluding Remarks 37
- Recommendations for Tower Bridge 38
- Final Reflections 39

References 40
- Bibliography 40
- Picture Credits 43

LIST OF FIGURES

Figure	Description
1	DCMS Survey on perceived amount of time for leisure: *DCMS-Sponsored Museum Visit Trends*, 2020
2	Consumer Confidence in the UK: *DCMS-Sponsored Museum Visit Trends*, 2020
3	Visits to DCMS Sponsored Museums by Visitor Origin: *DCMS-Sponsored Museum Visit Trends*, 2020
4	Visits to DCMS Sponsored Museums in London since 1998/99, mapped against claimed museum attendance: *DCMS-Sponsored Museum Visit Trends*, 2020
5	Archive structure of hierarchy
6	User interface for CollectionsIndex+, a Collections Management System
7	Comparison of the types of databases used in museums
8	Dublin Core: Processes and Principles: Weibel, 2005
9	The average importance, recorded on a scale of one to five, for 40 criteria from the CHIN abbreviated checklist
10	A sample system from the CMS options spreadsheet
11	Table comparing Spectrum Compliance
12	TMS Cataloguer Dashboard
13	CollectionsIndex+ Dashboard
14	CollectiveAccess Dashboard
15	Spreadsheet view for search results in CollectiveAccess
16	Axiell Collections
17	Proficio Elements
18	Weighted Value Analysis determined from the survey given to Tower Bridge staff
19	Visual representation of the Weighted Value Analysis determined from the survey given to Tower Bridge staff
20	Weighted Value Analysis from the WPI team
21	Final scores from the Weighted Value Analysis determined from the survey to Tower Bridge staff with Additional Considerations
22	Cost Comparison for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections
23	Cumulative Cost Comparison for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections
24	Additional Costs for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections
25	Object entry view with help function in CollectionsIndex+ demo
26	A sample asset from the Tower Bridge collection added to the CollectionsIndex+ demo
27	Default list view of the search results for “Canal”
28	A sample asset in Default view and the same sample asset in Minimalist view
29	Different views for search results in the Guildhall Art Gallery’s implementation of CollectionsIndex+: Nancy Wade

INTRODUCTION: A CENTRALIZED REPOSITORY FOR TOWER BRIDGE

THE BRITISH MUSEUM CONTAINS NEARLY TWO MILLION RECORDS AND 700,000 IMAGES

(GRIFFITHS, 2010)

Museums, like many other cultural institutions, are a product of the knowledge-centric spirit of the Enlightenment age and act as both repositories and interpreters of information (Enrico & Federico, 2011). Through the acquisition of artifacts, museums have developed enormous collections. For example, the British Museum contains nearly two million records and 700,000 images (Griffiths, 2010), and at any time only 1% of that is on public display (The British Museum, 2019). The extensive scope of such collections makes it crucial to have a well-organized system in place to help staff retrieve digital assets, develop exhibitions, and collaborate with other museums or scholars.

Digital technology can help museums achieve their educational mission through improved asset management, exhibition development, and visitor engagement. Moreover, with museum visitation declining in London (*DCMS-Sponsored Museum Visit Trends, 2020*), museums have turned to digital technology to help meet public expectations of museums as information resources (Williams, 2010). Studies have shown museum visitors expect museums to present some of their artifacts in digital archives (Marty, 2008) and want them to adapt to the technological age by providing services online that can facilitate access to assets and information about them (MacDonald & Alsford, 2010). Since 2016, the United Kingdom's central government has been pushing for more digitized collections (Vaizey, 2016). As of 2019, 60% of arts and culture institutions in the UK have already digitized significant portions of their collections (Mihelj et al., 2019).

Museums use Collections Management Systems (CMS) to organize digital collections. These software systems allow for the storage, indexing, search, and retrieval of assets and records contained in a database. CMSs provide interfaces for data entry, keeping inventory, and location tracking, while also improving the performance of administrative duties required for collections of cultural objects (Matassa, 2011). As an integrated system, CMS solutions can aid organization and management, streamline workflows, and establish procedures for managing assets at museums (Chin et al., 2019).

Tower Bridge, our sponsor, is a historic landmark in London that demonstrates the zenith of late Victorian architecture and engineering and is one of the premier tourist attractions in London (Tower Bridge: History, n.d.). The staff at Tower Bridge is interested in investigating the potential options for a CMS and how it could be implemented at Tower Bridge. This would improve its internal procedures and management of information; and in addition, might support any future plans and efforts towards accreditation as a museum.

The purpose of this project was to determine the most suitable CMS for Tower Bridge and provide support for Tower Bridge to learn about the implementation of the system. The team researched different options for a CMS and then used a weighted scoring to determine which option best suited Tower Bridge's needs. We researched the process of configuring the system to address the diverse needs of Tower Bridge and used feedback from peer institutions on the customization options for the system. Finally, we helped teach future staff how to use the system through the use of a user manual and pre-recorded training videos.

AS OF 2019, 60% OF ARTS AND CULTURE INSTITUTIONS IN THE UK HAVE ALREADY DIGITIZED SIGNIFICANT PORTIONS OF THEIR COLLECTIONS.

(MIHELJ ET AL, 2019)

BACKGROUND

Tower Bridge is one of London's most significant attractions, drawing over 800,000 yearly visitors before the COVID-19 pandemic (VisitEngland, 2019). As a historic monument and cultural icon, the Tower Bridge Exhibition provides a place for visitors to learn about Tower Bridge's construction and operation, as well as the important people who were involved in its story.

This background chapter will cover the ways that changes in museum operations, especially advancements in digitization and collections management systems, can help Tower Bridge organize assets and develop exhibitions. The first section will describe the history and purpose of museum collections and the various social and economic forces that have shaped cultural attractions and attendance by their visitors. The next section will consider ways museums can engage the public in modern times, especially through digital technologies. The following section will describe how database systems can be used in a museum context. The role of specific technologies such as Collections Management Systems will be covered in the next section. The final section will present a brief history of Tower Bridge and consider its need for a Collections Management System to document and organize the educational resources of Tower Bridge and aid its application for museum accreditation.

From Private Collections to Public Exhibitions: The History of Museums and their Visitors

Museums are establishments that conserve, study, and exhibit objects of cultural value (Hudson, 1975). With a long history dating back to Egypt in the third century B.C., they have since spread all over the world, making them a global concept (Arinze, 1999). Coming from the Greek mouseion meaning "seat of the muses," museums of the classical age were designated as places for philosophical contemplation and functioned as prototype universities with a focus on the interpretation of material heritage (Lewis, 2011). These early museums served as elitist institutions where scholars could expand their knowledge. The societal role of the museum has since broadened to one where both the general public and dedicated researchers can learn and engage with objects of cultural importance (Arinze, 1999).

The transition of museums from private collections, as they were until the Renaissance, into public exhibitions, from the Enlightenment period onward, was a distinctive feature of the modern conception of a museum (Lewis, 2011). Intellectuals in eighteenth-century Europe believed the preservation of artistic and scientific creations could help educate humankind and aid its progress in understanding the world (Alexander et al., 2017). In response, museums began functioning as public institutions with the opening of two of Europe's premier public museums, the British Museum in London in 1759 and the Louvre in Paris in 1793 (Lewis, 2011). While museums of pre-Enlightenment times gained reputations as institutions accessible mainly to the well-educated, Enlightenment ideals shifted the spirit of museums to appeal to a broader coalition of visitors who could appreciate their artistic and historical artifacts (MacDonald & Alsford, 2010).

The last century has seen an increase in preservation efforts at museums, helping drive museum growth (Brown & Mairesse, 2018). The years immediately following World War II were a period of remarkable growth for museums in a reconstructing Europe; a new approach emerged in which curators joined innovative teams of conservation scientists, designers, educators, and marketers to help promote museum collections to the public. This led to increasing popularity and attendance, and a large increase in the number of museums (Lewis, 2011). The European model of museums was highly successful in informing the public and influenced the growth of museums in the United States, which in 1988 had seen 75% of its museums founded since 1950. The growth of museums in Europe and the United States allowed them to increasingly serve as public information resources that preserve and promote cultural and historical heritage (Povroznik, 2018) and act as active repositories of information that create an understanding of different heritages (MacDonald & Alsford, 2010).

However, the increase in the number of museums open to the public has not always meant people utilize their resources, as many museums today face challenges with declining visitor attendance. While museum attendance steadily increased throughout the twentieth century as more people gained access to public exhibitions, Burton & Scott (2003), and Kelly (2004) state that wider trends in a recent decline in attendance can be attributed to competition in leisure time. As can be seen in Figure 1, although the perceived amount of time for leisure activities is positive, with 34% of respondents from a survey in London saying they have more time for leisure compared to three years previously (*DCMS-Sponsored Museum Visit Trends*, 2020), consumers are increasingly looking for experiences that allow for immersion and active participation in contrast to previous absorption and passive participation (Pine & Gilmore, 2001). Expectations for entertainment have shifted to encompass more "personalization, individualism, novelty, and 'Instagrammable' moments" (*DCMS-Sponsored Museum Visit Trends*, 2020). The cultural sector has always been central in the market for experiences, but more competition has created a fragmented market where museums are left to compete with each other in addition to other leisure activities.

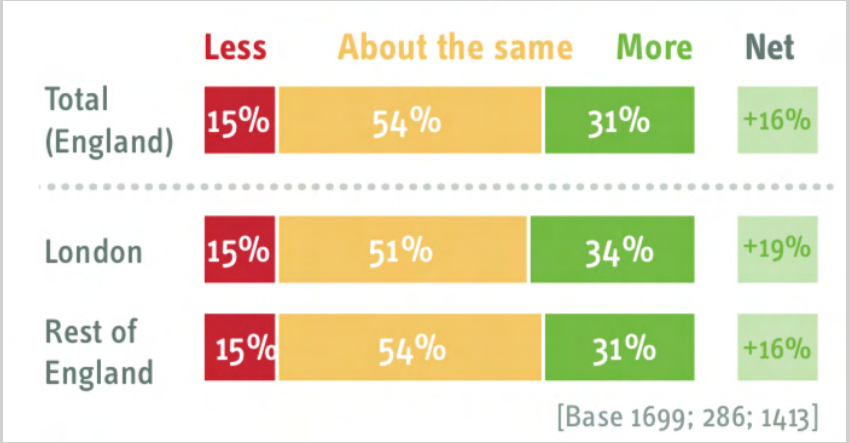


Figure 1: DCMS Survey on perceived amount of time for leisure (DCMS-Sponsored Museum Visit Trends, 2020)

In addition to declining attendance due to social factors relating to perceptions of leisure, economic trends play an important role in the visitation at London museums. Recent surveys conducted by the Department for Digital, Culture, Media and Sport (DCMS) have shown that the top reasons for fluctuating museum attendance in London are economic, with the most cited deterrents being the cost of travel, cost of tickets, and decrease in disposable income (*DCMS-Sponsored Museum Visit Trends*, 2020). Studies concluded a direct correlation between consumer confidence in the UK and visit patterns to UK museums, as seen in the DCMS Figures 2 and 3. The peak of UK consumer confidence coincides with the peak of museum visitation trends by international and UK visitors, and subsequent fluctuations in consumer confidence coincide with fluctuations in UK museum visitations. While the overall trend of museum visitation has increased since 1998, as can be seen in Figure 4, fluctuations in claimed museum attendance are visible in more recent years, with claimed museum attendance in London falling sharply from 62% to 41% in 2017 and then rising to 50% in 2018. On aggregate, data from DCMS shows economic trends can influence museum attendance, and as a whole visitation is not entirely stable.

Although museums have seen significant growth in visitors as they transitioned from private collections into public exhibitions, there is still a need for understanding the visitors who may attend them. Both social and economic trends show that museum attendance is more fragile than people anticipate, and the proliferation of media such as video games and movies has pushed museums to develop an image that is attractive to the public (MacDonald & Alsford, 2010). The increasing appetite of visitors to have "more unusual, immersive, and personalized experiences" influences attendance (*DCMS-Sponsored Museum Visit Trends*, 2020). As a part of society, museums have considered the "interactional context" between museums and visitors to most effectively serve the public as educational institutions (Graburn, 1977), but have recently recognized the need for new strategies that entice visitors in a digital age (Enrico & Federico, 2011).

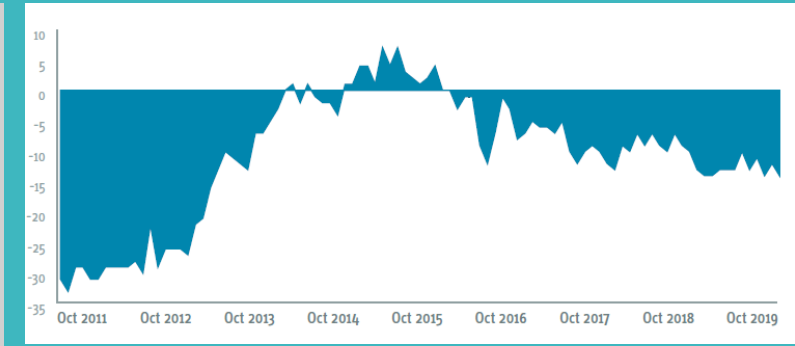


Figure 2: Consumer Confidence in the UK (DCMS-Sponsored Museum Visit Trends, 2020)

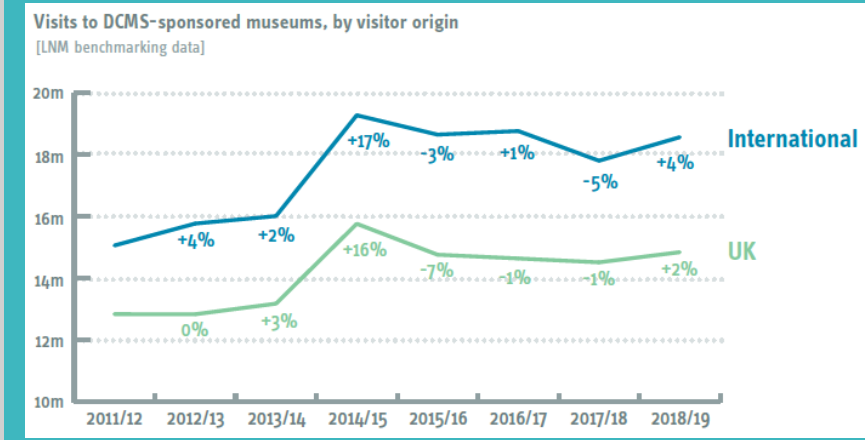


Figure 3: Visits to DCMS Sponsored Museums by Visitor Origin (DCMS-Sponsored Museum Visit Trends, 2020)

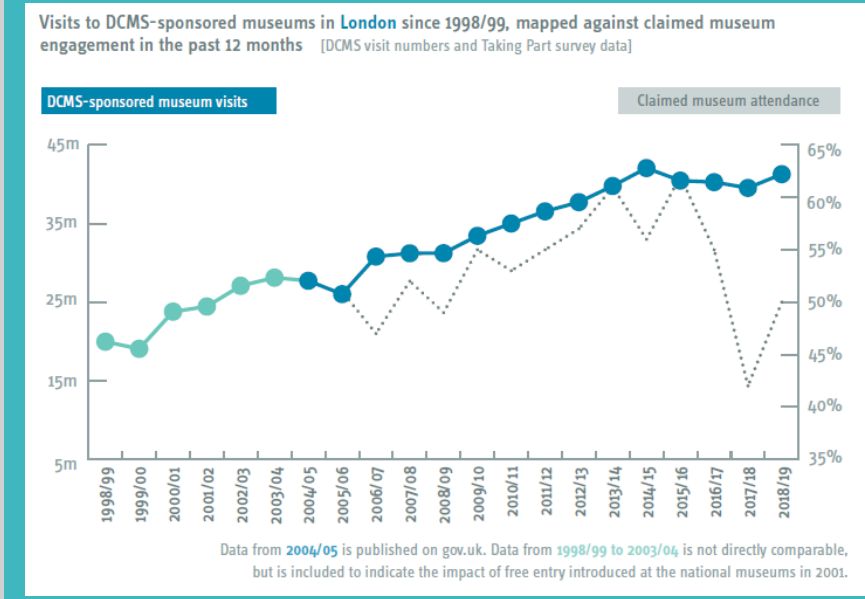
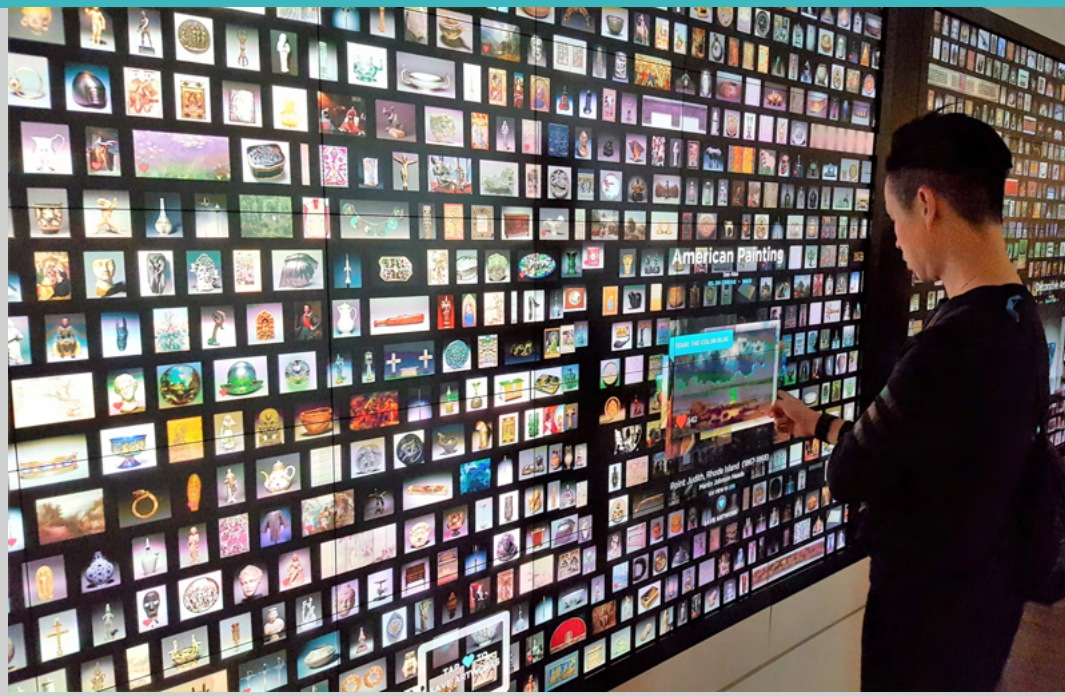


Figure 4: Visits to DCMS Sponsored Museums in London since 1998/99, mapped against claimed museum attendance (DCMS-Sponsored Museum Visit Trends, 2020)

Implementation of Digital Technology to Increase Public Engagement with Museums

To combat recent trends in declining attendance, museums can focus on effectively utilizing their resources for exhibition development. Current technological advancements in computers have allowed for a new presentation and interpretation medium (Parry, 2013). Visitors remark on the interactive qualities of exhibits that utilize computers. These exhibits have been the most successful in drawing in new visitors and repeat visitors. Through the use of computers, museums can implement multimedia to develop advertisements or have participatory projects, allowing for increased efficiency of museum staff and re-engagement with the public (Chin et al., 2019). The modernization of museum resources has allowed for "total media collections" consisting of oral histories, photographic and audiovisual materials, digital databases, and live cultural performances. These are holistic online collections that augment traditional mediums of exhibition delivery in physical museums (MacDonald & Alsford, 2010). Using more multimedia when developing exhibits has been shown to connect visitors with the exhibits and create more personalized interactions that engage the public (Grohe, 2020); museum staff can use "total media collections" when developing exhibits to display historical and cultural assets in an enticing way (Ciolfi & McLoughlin, 2012).

Although modernization has opened the door for more elaborate and streamlined exhibition development and display, museums that have considered cultural inclusivity to effectively implement these changes have had success in engaging more diverse audiences (*Museums 2020 Discussion Paper*, 2012). According to the DCMS, developing advertisements and exhibits that are more inclusive to a diverse audience can help museums gain more interest (*DCMS-Sponsored Museum Visit Trends*, 2020). Studies on how Black African, Black Caribbean, Indian, Bangladeshi, and Chinese men and women view museums have shown that they still believe that they are for intellectuals and elites (Hooper-Greenhill, 1999).



Additionally, these ethnic groups felt marginalized by museums as they originally portrayed only white people's perspectives (Kegan et al., 2017). To maximize the potential audience that the museum can reach, Grohe (2020) asserts they have to consider developing displays that cater to more local, diverse, and younger audiences. The growth of social web technologies in the early 2000s allowed museums to implement participatory practices that included a wider audience (Srinivasan et al., 2009). These participatory practices allow museums to co-develop exhibits, using the input from diverse audiences to expand their collections and have a more inclusive way to engender interest. The exhibits were extremely successful, drawing in large crowds that commented on the inclusivity of the displays (Simon, 2010).

A publicly accessible collection can help museums satisfy public expectations for education, bolstering public engagement. A 2008 survey revealed that a majority of museum visitors believe a museum's website should function as a digital library or archive, and many desire 24-hour online access to museum data (Marty, 2008). 62% of survey respondents were likely or very likely to use museum websites to find research materials, and 64% of respondents were likely or very likely to use museum websites to find online images of artifacts. To meet these expectations, some museums have begun to publish versions of their digital collection on their public website (Mihelj et al., 2019). In the United Kingdom, over 3,300 museums and cultural venues currently contribute to Art UK, a charitable organization that compiles pictures and digital records from these organizations into one highly searchable collection (Vaizey, 2016). By implementing an external digital collection and a well-designed web page, modern museums can meet this expectation and continue bringing education and enjoyment to visitors, both remotely and in person.

The 2020 COVID pandemic emphasized the importance and effectiveness of digital delivery methods and publicly accessible collections. By May 2020, 5 months after the pandemic became worldwide, the International Council of Museums in partnership with UNESCO found that 90% of museums had closed due to the pandemic and 13% were on the verge of closing forever (Brownell, 2020). In response, some museums implemented digital engagement to supplement museum income. In 2021, a study on the impact of COVID-19 on 83 large and small historic, art, polythematic, and science museums in the UK and USA found that the museums in total had created 922 digital offerings to increase engagement while less prepared museums were forced to cancel new exhibitions as they had no way to display them (Samaroudi et al., 2020). The Masterpiece London Art Fair was able to take advantage of digital collections to regroup and move online in June 2020. The art fair was successful, showing that the impact of COVID-19 could have been mitigated had museums made digital copies of their collections to allow them to take advantage of online exhibits (Brownell, 2020).

Minesweepers off Duty
1940
Charles Ernest Cundall (1890–1971)

A Destroyer Escort in Attack
1941
Richard Ernst Eurich (1903–1992)

Scene on the River Conwy, Betws-y-Coed
1880
Edward Henry Holder (1847–1922)

Ouse Bridge
unknown artist

Portrait of an Unknown Elderly Man with Moustache
1885–1895
unknown artist

A Middle-Aged Lady of the Agar Family
William Higgins (b.1759)

IN THE UNITED KINGDOM, OVER 3,300 MUSEUMS AND CULTURAL VENUES CURRENTLY CONTRIBUTE TO ART UK, A CHARITABLE ORGANIZATION THAT COMPILES PICTURES AND DIGITAL RECORDS FROM THESE ORGANIZATIONS INTO ONE HIGHLY SEARCHABLE COLLECTION
(VAIZEY, 2016)

In addition to providing ways for the public to access museum resources online, museums can also stimulate public interest by facilitating active participation in the development of digital collections (Parry, 2013). While museums throughout the twentieth century co-developed physical exhibitions with community members, these participatory projects were often institutionally defined, time-limited, and involved only a small number of participants; only recently with the growth of social web technologies in the mid-2000s has participation been transformed from something limited and infrequent to something more readily available and digitally accessible (Simon, 2010). Museum participation can include projects that promote user-submitted content on cultural or historic topics, and these efforts allow museums to move past a traditional catalog by adding community-sourced artifacts to digital collections in use for education (Srinivasan et al., 2009).

For example, in 2008, the San Jose Museum of Art created an interactive exhibit that was promoted on YouTube. The museum made a video requesting people to send in postcards from their road trips to be displayed in the exhibit. The video received over 80,000 views and helped the museum to receive over 200 postcards (Simon, 2010). Digital technologies, which can be used to expand access to existing museum resources as well as to increase participation in the submission of user-sourced artifacts, are important in developing museums that enrich visitors with visual content and encourage visitors to visit the physical museum (Bowen, 2000). However, the backbone of any public website or online digital collection is a well-established database for internal organization (Sully, 2006).

Databases in a Museum Context

Computerization was introduced to museums in the 1960s when mainframe databases were frequently used for tasks like payroll and accounting (Williams, 2010). Once computing power had dynamically increased, digital collections were created. Digital collections are databases with the capacity to store and edit digital records of a museum's collection. They make it easier to keep track of, search through, and form sub-collections of their items and have been widely adopted by museums and historical organizations. A 2019 paper published at Loughborough University reports that over 60% of arts and culture institutions in the United Kingdom have already digitized significant portions of their collection (Mihelj et al., 2019).

Digital technology is crucial for maintaining and preserving a large collection of assets (Simmons, 2016). At a museum, a digital collection can be used to catalog information on the items in a museum's collection. Cataloging is a broad term that describes the process of providing access to materials through formal descriptions and organizing the descriptions in a way that will connect user queries to the relevant materials (Barts Archives, 2017). Properly cataloging an institution's internal collection allows the items to be more accessible to researchers. Every institution has a unique collection, and these can encompass various kinds of materials. This has led to the development of many types of databases to accurately model the collection they represent through the use of metadata, which describes and gives information about other data. A digital collection generally refers to any system of digitized records accessed through a database, but there are specific kinds of digital collection software that focus on certain kinds of entries.

One example of a database that can be used is the archive. Libraries and collections with a large number of books or other printed materials are most likely to use archives for organization and documentation (F. Kelly, 2019). Kelly describes how archival databases focusing on these types of assets can help institutions deal with the increasing amount of digitized print matter through a structured organization.

Archives work with a hierarchical structure, in which things are arranged in levels; catalogs go from broad to narrow, with "fonds" being the broadest and "item" being the narrowest, as shown in Figure 5 (The National Archives, 2018). This structure allows archives to keep the context in which records have been created as well as the network of relationships between them (Barts Archives, 2017). Collections that need this kind of organizational structure will implement a hierarchical archive within the database.

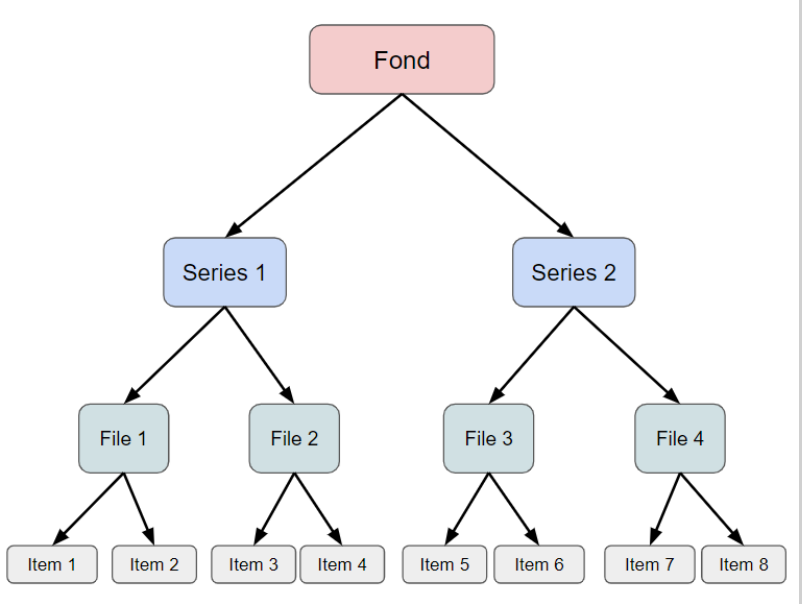


Figure 5: Archive structure of hierarchy

Another example of a database that can be used in a museum context is a digital asset management system (DAM). A DAM provides a hierarchical structure of directories similar to an archive database, however, DAMS are better tailored for institutions that need to store and categorize digital media like photos, videos, documents, and audio clips (Jacobsen et al., 2005). DAMs can be used as an internal resource for an institution, or as an external resource for soliciting user-submitted media content from the public. In contrast to archives, a DAM will be much more focused on multimedia and have more flexibility on the types of media that are cataloged.

A collections management system (CMS), as shown in Figure 6, interfaces with a database to manage records of physical and digital assets. They are commonly used for storing records on inventory and generating reports, though these systems often have added functionalities like tracking inventory location and reporting on an asset's physical condition (Sully, 2006). Collections management systems also let users add metadata tags to the digital records, which enhances the process of describing a museum asset. Descriptive metadata closely resembles traditional cataloging, but because the records are digital, users can search for, access, and understand museum objects much more easily than through traditional cataloging (Baca et al., 2008). Collections management systems often integrate relational databases into the system to associate metadata terms across different records.

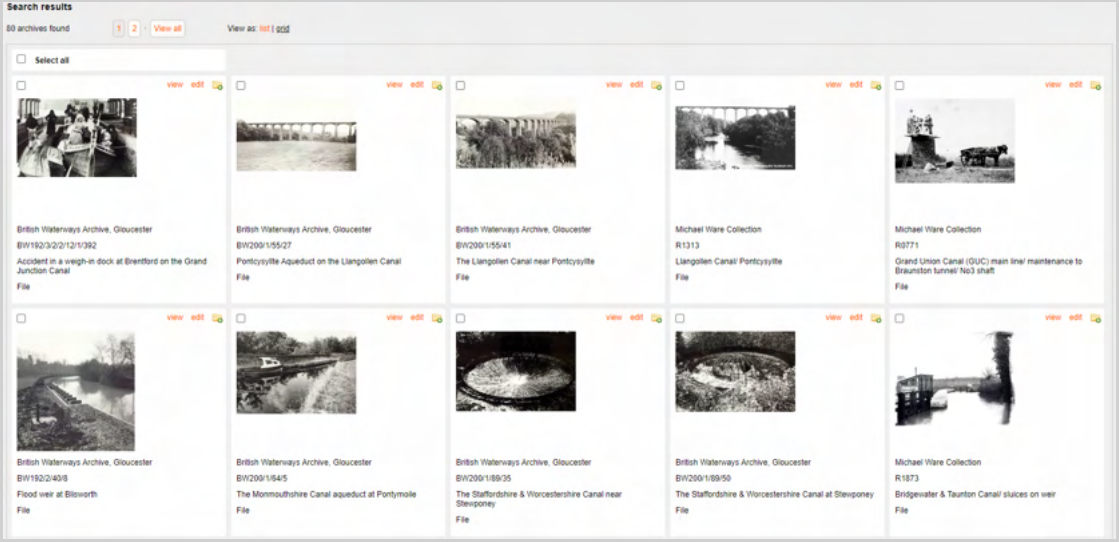


Figure 6: User interface for CollectionsIndex+, a Collections Management System

The databases previously described (archive, DAMs, CMS, as shown in Figure 7) are often constructed as relational databases. Relational databases store and provide access to data that are related to one another and can help organizations track the interactions between items in a secure, rules-based, and consistent way (*What Is a Relational Database?*, n.d.). In the context of museums, relational databases make it easy to associate assets with entities that are closely connected with them, such as the artist or maker of the asset or the locations and events associated with it.

Database	Structure	Items Stored
Archive	Hierarchical	Photographs, books, written materials
DAM	Non-hierarchical	Images, video, audio, digital media
CMS	Either hierarchical or non-hierarchical	Physical objects, paintings, multimedia

Figure 7: Comparison of the types of databases used in museums

Metadata, which is data about the data, is crucial in the discoverability of objects in the collections. Access points are specific metadata tags that can include personal and corporate names, places, and titles; these access points allow those who use the database to find the associations between entities and items contained in the database of assets. Additionally, relational databases offer authority control, which is the process to maintain control over the access points in a catalog (Jeng, 2002). Authority control also gives a limited number of users quality control over the language that can be used for searching, allowing for retrieval of information with high precision.

Dublin Core

Due to the wide variety in the way databases are designed, certain standards have been developed for metadata. In 1995, a report was published proposing a simple set of thirteen metadata descriptors that are important for cataloging (Weibel, 1995). These eventually became known as the Dublin Core, which is a commonly used database standard, as shown in Figure 8. Focusing on basic cataloging terms like "Subject", "Title", "Date" and "Author", the Dublin Core standard is intended to be accessible by those without formal knowledge in the field of museum cataloging (Weibel, 2005). Along with metadata standards, collections management systems are also governed by procedural standards for cataloging.

Table 1. The Fifteen Elements of "Simple Dublin Core"

Identifier	Definition
Title	A name given to the resource.
Creator	An entity primarily responsible for making the content of the resource.
Subject	The topic of the content of the resource.
Description	An account of the content of the resource.
Publisher	An entity responsible for making the resource available.
Contributor	An entity responsible for making contributions to the content of the resource.
Date	A date associated with an event in the life cycle of the resource.
Type	The nature or genre of the content of the resource.
Format	The physical or digital manifestation of the resource.
Identifier	An unambiguous reference to the resource within a given context.
Source	A reference to a resource from which the present resource is derived.
Language	A language of the intellectual content of the resource.
Relation	A reference to a related resource.
Coverage	The extent or scope of the content of the resource.
Rights	Information about rights held in and over the resource.

Figure 8: Dublin Core: Processes and Principles from S. Sugimoto, T. Baker, & S. Weibel

Spectrum

The Collections Trust, a charity in the United Kingdom, has developed a standard for collections management systems called Spectrum. While Spectrum originated in the UK, it is used all around the world in a growing number of countries and has been translated into ten different languages (*Spectrum around the World – Collections Trust*, n.d.). The Spectrum standards outline the important features for a CMS system, identifying nine primary procedures which provide a baseline for what a good CMS should be able to do (*Introduction to Spectrum 5.0 – Collections Trust*, n.d.). Some of these procedures focus on object entry, acquisition and accessioning, and location. Object entry is the process a user needs to invoke to add new objects and enter all relevant relational information and metadata about them into the database. Acquisition and accessioning is a procedure that verifies proof of ownership and links the object to the information on it. Location and movement control is a procedure that keeps track of the location of the object and updates it when it moves. Additionally, the procedures mandate the continual improvement of your documentation systems and the information they contain.

THE NINE SPECTRUM PROCEDURES ARE:

- OBJECT ENTRY
- ACQUISITION AND ACCESSIONING
- LOCATION AND MOVEMENT CONTROL
- INVENTORY
- CATALOGUING
- OBJECT EXIT
- LOANS IN
- LOANS OUT
- DOCUMENTATION PLANNING

(THE COLLECTIONS TRUST, 2017)

Identifying Options for Collections Management Systems

Collections management systems are essential in the growth of museum collections in the twenty-first century because they enable managing the information about the collection, avoiding duplicate entries, and improving communication between departments (Swank, 2008). In a 2016 survey of 236 museums, the Canadian Heritage Information Network (CHIN) found that 34% of respondents that used software to manage their collections chose Excel or other such basic options (Canadian Heritage Information Network, 2017a). While Microsoft Excel or other spreadsheet programs can be an easy solution and simple to set up, they lack much of the automation and standardization present in most CMS. Additionally, they have no way to avoid duplicate entries, and they cannot facilitate communication between departments. Spreadsheet programs lack real-time collaboration, which allows multiple users to make changes at once, and they also lack a multi-leveled approach, which provides different access permissions for different types of users.

Of the available CMS options that can be implemented by museums, there are two main categories relating to the way information is hosted, or stored and managed. Local servers can be purchased by a museum to store information on hardware on-site, while cloud-based options are characterized by renting server resources from external entities (*Cloud vs Local Servers*, 2019). For those without pre-existing server infrastructure, the up-front investment may cost more than leasing services from more established storage providers ("The Pros and Cons of Cloud vs in House Servers," 2019). Museums that use cloud-based storage can more readily expand their storage and can often rely on their hosting service provider to provide automatic backups. Due to reliance on an active internet connection, a cloud-based CMS is vulnerable to internet slowdowns and outages (*On-Premise vs. Cloud Pros and Cons | Which Is Better?*, 2019).

There are also differences in collections management software between commercial and open-source products. Many vendors that provide a CMS also offer technical support for the setup and upkeep of the systems. However, the potentially high costs can make such systems hard for museums to secure funding for. In contrast, open-source products developed by members of the user community can provide a cheaper alternative that also allows for more customizability (Amy Smid, Personal Communication, 2021). Open-source software often has freely accessible source code that anyone can inspect, modify, and enhance, allowing programmers to add features or fix parts that are not working correctly (*What Is Open Source?*, n.d.). However, this increased customization requires more technical knowledge and may be more complex for users to develop and manage, requiring a larger time investment.

A large barrier to entry with these systems is the lack of knowledge on where to start in the process of implementing a CMS (Sully, 2006). Some good first steps are to identify the user base, important features for those users, where the money for the system will come from, and where you can find more about these systems or the people who will be using them. Many museums falter at the final step of identifying how to find a good system and just use a makeshift one themselves. In response, the Canadian Heritage Information Network (CHIN) created a tool to help identify the best option for each specific use. They created the Collections Management System Criteria Checklist (CMSCC) (Appendix A), based on Spectrum's primary procedures, specifically to be used as a resource for museums and exhibits. In addition to providing the checklist for the museum to use, they provide grades for several commercial and open-source CMS based on how well each software fulfills the different areas put forward in the checklist (Canadian Heritage Information Network, 2017b). There are two versions of the checklist: the full version has over 800 criteria, and the abridged version, which is meant for a smaller institution, has closer to 300 criteria. The broad categories of CHIN's CMS checklist include core CMS features such as Object Entry, Acquisitions & Accessioning, and others based on the Spectrum procedures, as well as secondary features for report generation and system administration. There are many CMS options on the market, but the checklist can help a museum narrow down options to those most relevant to the intended use of the system by identifying what functionalities will need to be accomplished by the CMS.

Tower Bridge and Its Need for a Collections Management System

Tower Bridge is one of the most recognizable landmarks in London, and to this day fulfills its role as a living bridge, heritage site, events venue, and tourist attraction (*Tower Bridge Interpretation Plan*, 2015). The site has documentary value that reveals information about past human activity in London during the nineteenth and twentieth centuries, historical value as a lens to view the engineering and architecture of the late Victorian-era, aesthetic value as a source of sensory and intellectual stimulation, and communal value by paying tribute to the collective memory of London.

Construction started in 1886, and Tower Bridge was officially opened in 1894. The movable bridge is of the drawbridge type and spans the River Thames between the Greater London boroughs of Tower Hamlets and Southwark, adjoining the Tower Of London (*Tower Bridge | Description, History, & Facts | Britannica*, n.d.). Over 50 designs were submitted to the City of London Corporation to design a bridge downstream from London Bridge that would not disrupt river activities, and in 1884, Sir Horace Jones and Sir John Wolfe Barry's design was selected as the plan for Tower Bridge (*Tower Bridge: History*, n.d.).

It took eight years, five major contractors, and the labor of hundreds of workers at any one time to build the bridge, and when completed, Tower Bridge was one of the most sophisticated bascule bridges in the world (Tower Bridge: History, n.d.). The Bridge is about 800 feet in length and provides an opening 250 feet wide when the drawbridge is raised. Tower Bridge was operated by hydraulic pumps driven by steam until 1976 when electric motors were put into operation and the steam power was repurposed as a tourist display (Tower Bridge | Description, History, & Facts | Britannica, n.d.). In 1910, two high-level walkways were designed and added so the public could still cross the bridge when it was raised, and they remain popular attractions today (Tower Bridge: History, n.d.). Tower Bridge first opened to the public in 1982 with a permanent exhibition inside called The Tower Bridge Experience and has served as a cultural center since then.

Tower Bridge in 2010

Paintings of Sir Horace Jones (left) and Sir John Wolfe Barry (right). Tower Bridge Collection

A notable element of the 2012 London Olympics, the Olympic rings were suspended from the Walkways, and Tower Bridge featured during the opening ceremony. With its rich history and aesthetic and cultural importance, Tower Bridge is a significant landmark with a substantial place in the consciousness of London and the United Kingdom.

Tower Bridge serves the public as an attraction that provides the important history of the bridge as well demonstrations of its past and present operation. Tower Bridge's main revenue stream comes from ticket sales, gift shop items purchased by visitors, and through its role as an events venue and film location, but Tower Bridge has been closed for over a year due to the pandemic. As they plan their reopening, Tower Bridge would like to expand its documentation and exhibition of artifacts, improve its operations, and increase revenue by becoming an official museum.

Because Tower Bridge is considering applying for official classification as a museum (Dirk Bennett, Personal Communication, 2021), it needs a Collections Management System for its staff to be able to organize artifacts and store multimedia relating to the history of the Bridge and fulfill its purpose as a forum for education. In the United Kingdom, all accredited museums must comply with the Spectrum standard, which ensures the effective management of museums (Introduction to Spectrum 5.0 – Collections Trust, n.d.). With Tower Bridge currently in the process of its accreditation application to become an official UK museum, it must show its plan to achieve the Spectrum standards for these procedures. A CMS is one of the primary facilitators in standardizing museum operations and will make it easier for Tower Bridge to demonstrate its proficiency in museum procedures.

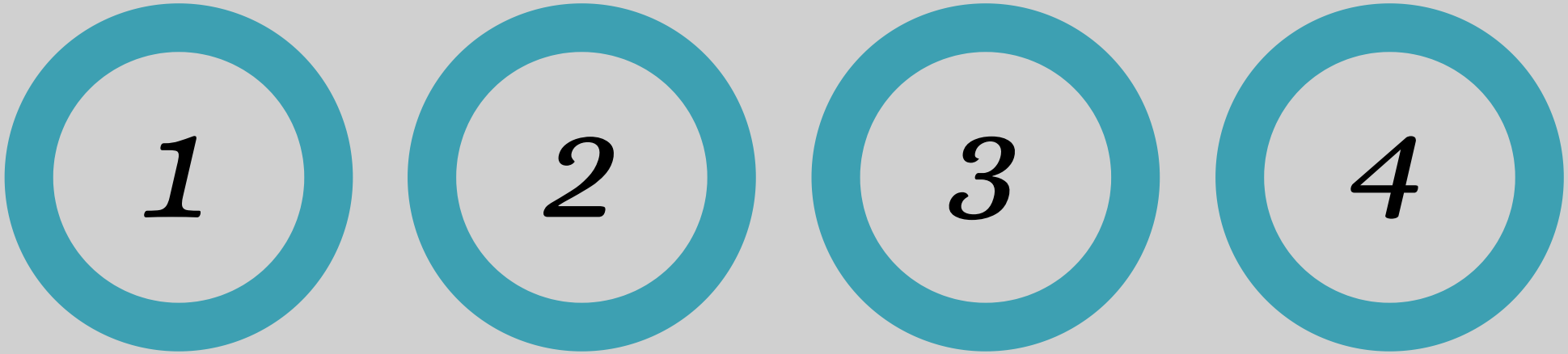
With exhibitions having such an important role in the operation and budget of Tower Bridge, it is important to have well-curated and targeted displays that attract and inform visitors. The implementation of a Collections Management System can help ensure better internal organization, leading to more effective, interesting exhibits and more visitors to Tower Bridge.

A previous Tower Bridge IQP project recommended making changes to displays to improve visitorship (Cunningham et al., 2019). Having better internal organization will allow Tower Bridge curators to continue focusing on cultural preservation (Bowditch, 2015; Williams, 2010). A well-implemented Tower Bridge CMS can promote inter-organization collaboration, providing access to other museums and academic communities. Through the use of a robust CMS, Tower Bridge can better serve its educational role and enrich the public. Additionally, the increased efficiency provided by a CMS would directly benefit the activities of the Bridge House Estates charity, which receives the majority of the income generated by Tower Bridge.

From the Tower Bridge Interpretation Plan, one can see that non-permanent community engagement projects and interactive content are already planned as integral parts of Tower Bridge's operations (*Tower Bridge Interpretation Plan*, 2015). A CMS can bolster the internal organization of Tower Bridge assets, making it easier to follow through on these plans. Our project addresses Tower Bridge's options for implementing a CMS, taking into consideration questions about the needs of the staff and the collection of assets at Tower Bridge. By conducting extensive research, the project investigates what can be done to implement Tower Bridge's CMS and provides recommendations for how the system can function as an easy-to-use, secure, and scalable centralized repository.

METHODS

The goal of our project was to lay the foundation for a CMS for Tower Bridge to help its staff organize assets into a centralized repository. This project also included providing support resources on how to use the system. We identified four main objectives to guide our project:



1. Research potential CMS options and identify the key features of each system
2. Choose a system that best fits the needs of Tower Bridge using a weighted value analysis
3. Research the implementation options for the chosen system, using feedback from the software vendor and staff at peer institutions as guidance
4. Develop training videos that can be expanded in the future as needed

Objective 1: Research potential Collections Management Systems

We researched potential options for a CMS and documented the various features such systems included. Our sponsor identified three crucial criteria to evaluate a CMS: ease of use, scalability, and security. We added additional criteria as we researched the potential options and surveyed Tower Bridge staff to identify their priorities for a CMS. We looked at 10-12 CMS options spanning categories such as web and cloud-based, local-based, and open-source.

Our preliminary research into the available CMS options was guided by questions such as:

- What kinds of software categories are used for a CMS?
- What systems can handle the asset types present at Tower Bridge including photos, oral histories, plans, document types, and objects?
- Around how many assets will need to be stored and which storage solutions have that capacity?
- How will information on the CMS be hosted?
- Will the CMS be able to interface with tabular data such as in Excel spreadsheets?

The CMS options we investigated were evaluated on a variety of criteria, including many that were later used to create the weighted value analysis in Objective 2 (See Appendix C). Some of these criteria include:

- Total storage capacity
- Number of simultaneous users
- Licensing options and associated costs
- Searching, query, and metadata features
- Ease of use and intuitive user interface
- Security, reliability, and backup features
- Compatibility with other databases and Excel
- Hardware and installation costs and requirements
- Availability and price of technical support

To answer questions on the available software options and their advantages and disadvantages, we primarily conducted online research by going to the websites of various CMS vendors and finding information on important factors for each CMS option. We then contacted the vendors for demonstrations and quotes of the systems to understand the capabilities of different collections management systems. We supplemented our online research with insights from compilations of various CMS options from museology-related organizations, such as the Canadian Heritage Information Network (CHIN) and the UK Collections Trust.

Key informant interviews were an effective way to get information from people who have first-hand experience with collections management systems. We conducted key informant interviews with the following experts:

- Amy Smid from the WPI Archive
- Nancy Wade and Alexandra Walker from the Guildhall Art Gallery
- Terri Dendy from the National Army Museum

These interviews explored the process of choosing a CMS and the important features of a CMS in both museum and archive settings (See Appendix D). The key informants included people familiar with the state of museums in London as well as a contact who is more involved with collections in Worcester.

The final result of this phase of the project was a comprehensive list of CMS options with information on the key features and prices.

Objective 2: Choose the system that best fits the needs of Tower Bridge

After identifying potential collections management systems for Tower Bridge, the project team then analyzed the options and chose the CMS that is best suited for Tower Bridge. Choosing the most effective CMS for Tower Bridge was not a trivial task. To ensure that the system we implemented is used efficiently and effectively, we first researched the following:

- What are Tower Bridge's primary and secondary needs for a CMS?
- What level of complexity is Tower Bridge looking for in a CMS?
- What is Tower Bridge's budget for the CMS?
- Is Spectrum compliance a necessity for a CMS?

We discussed these questions with Tower Bridge Exhibition Director Dirk Bennett and used the information to narrow down our list to 5 potential collections management systems that were considered in our final research.

The team constructed a weighted value analysis (see Appendix C) to determine the best CMS for Tower Bridge. To create the criteria for this analysis, we used the information from our previous key informant interviews along with input from our project sponsor Dirk Bennett. This wide range of informants allowed us to get a good understanding of what a CMS should provide. The key informant interviews also offered viewpoints outside of Tower Bridge, which we compared against our research and our interviews with Dirk Bennett. Our main points of discussion in our interviews were collections management systems and their:

- Strengths and weaknesses
- Size of collection and types of artifacts
- Cost
- Essential and nonessential qualities

A detailed interview plan can be found in Appendix D.

Comparing criteria we identified in our background research with those from the interviews enabled us to generate appropriate criteria to evaluate a potential CMS. This list of criteria was discussed with our sponsor and his colleagues at Tower Bridge for final approval. The list of the criteria for the weighted value analysis included:

1. Layout & Ease of use
2. Scalability & Future uses
3. Scope& Fitness
4. Maintenance & Support
5. Searching
6. User groups & permissions

	Layout & Ease of use	Scalability & Future uses	Scope & Fitness	Maintenance & Support	Searching	User groups & permissions
Weight (1-100)	90	80	70	60	50	50

To determine the weights for each criterion, we created surveys that asked participants to weigh the criteria on a five-point scale from "Not at all important" to "Very Important" (Appendix E). The decision to use a 5-point scale was corroborated by the findings of Friedman and Amoo, whose 1999 article in the Journal of Marketing Management concluded "researchers should consider using 5 to 11-point scales" depending on the stimulus being tested (Friedman & Amoo, 1999, p. 114). Friedman and Amoo also made a point about using a scale with too many points: "using more points than the subjects can handle will probably result in an increase in variability without a concomitant increase in precision" (Friedman & Amoo, 1999, p. 118). As such, we decided to primarily use 5 to 11-point scales in our surveys to avoid potential overcomplication. These surveys were distributed by Dirk Bennett to the appropriate members of the Tower Bridge staff.

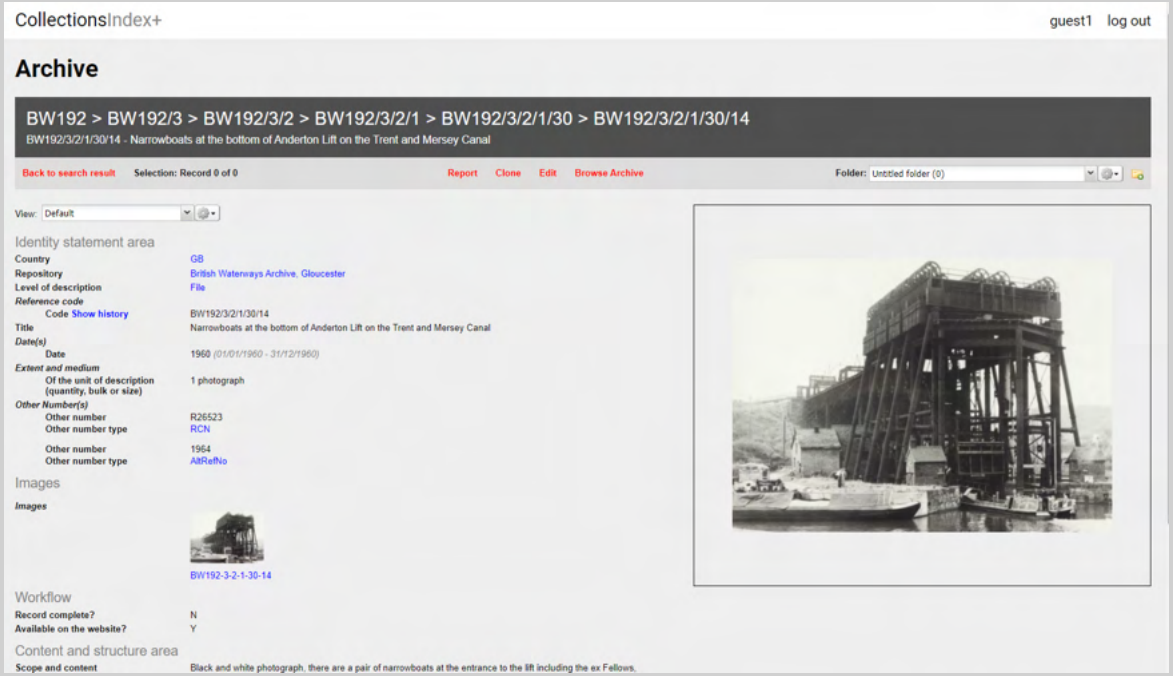
Objective 3: Research the implementation of CollectionsIndex+

Once CollectionsIndex+ was chosen as the best CMS for Tower Bridge, we investigated more options for the set-up, customization, and maintenance of the system. To begin the process, we familiarized ourselves with CollectionsIndex+ by using a provided online demo to give us a better understanding of the system's functionality. Because Tower Bridge's different departments (Technical, Marketing, Education, Exhibition Development, and Visitor Operations) have unique needs from a CMS, we needed to ensure the implementation of CollectionsIndex+ could match the needs of the different groups.

Although we had previously done an in-depth analysis of the capabilities of the system, we needed more specific information on the aspects of the system that could be changed to meet Tower Bridge's needs. To achieve this, we conducted another key informant interview with representatives from SSL, the vendor of CollectionsIndex+. In this interview we asked questions about the next steps Tower Bridge would need to take to implement the system and what available customization options SSL offers. Some of the questions asked included:

1. What steps will Tower Bridge have to take to get the CMS up and running?
2. Is it possible to continue customizing after the CMS instance is running?

The full list of interview questions for SSL on the implementation of CollectionsIndex+ at Tower Bridge can be found in Appendix G.



To gather further feedback on the use of CollectionsIndex+, we distributed a written questionnaire through Dirk Bennet to other institutions in London using CollectionsIndex+. However, we only heard back from the Guildhall Art Gallery before our project came to a close.

The questionnaire asked questions about how each institution used CollectionsIndex+, what steps they took for customization, and how the user training, support, and maintenance provided by SSL allowed them to match the implementation of the system to their institutional needs. The full list of questions can be found in Appendix H.

Objective 4: Develop User Training Videos

Our project's fourth objective was to develop user training for CollectionsIndex+. This series of videos was to be used as a resource to help familiarize Tower Bridge staff with the CMS. The project sponsor prioritized easy access and use, so we intended for this manual to consist of videos that made it easy for new users to get started.

Once we selected CollectionsIndex+, we needed to know if SSL had a user manual or any other resources. We learned about the features of the software from SSL and other CollectionsIndex+ online resources (including the help manual) to make our videos more thorough and effective. Our team utilized video-editing software to create the tutorial videos. A Columbia study on instructional videos found that the average amount of time viewers watch media is approximately 4 minutes (Hibbert, 2014), so we aimed to keep our videos under a four-minute duration. The videos were part of the final deliverable. Our videos only covered the basic functionality of CollectionsIndex+, so the collection of videos delivered left a window open for future expansion with more videos on the advanced functionality of the CMS.

Thumbnails from the tutorial videos

FINDINGS

Our findings utilized online research, interviews, surveys, live presentations of software, and self-guided software demos to draw conclusions about potential collections management systems for use at Tower Bridge. In this chapter, we first discuss our findings on the important features for a CMS at Tower Bridge. Next, we review the process by which we identified and eliminated potential CMS options for Tower Bridge. We then present our findings from an in-depth analysis of 5 potential CMS options. Finally, we show the Tower Bridge staff's evaluation of these 5 potential systems and how their evaluation compares to our own. The result of these findings allowed us to provide Tower Bridge with sufficient information about CMS options to guide their final decision of the CMS to purchase and implement. Finally, we discuss Tower Bridge's choice for a CMS, CollectionsIndex+, and describe how the system can be customized and implemented to meet the needs of the staff at Tower Bridge.

Important Features for a Collections Management System at Tower Bridge

To identify important features for a CMS, we held interviews with representatives from the Guildhall Art Gallery and the National Army Museum. These representatives gave us key insights into the CMS used at their respective organizations and made recommendations for our project. These interviews gave us valuable information about some important CMS features: flexible hosting, user training, Spectrum compliance, accessioning, and object entry.

Flexible Hosting

Alexandra Walker and Nancy Wade from the Guildhall Art Gallery use CollectionsIndex+, a CMS commonly used at museums in London. They made us aware of a valuable feature of collections management systems: flexible hosting. Flexible hosting allows an institution to switch between cloud-hosted and local-hosted solutions. CollectionsIndex+ can be cloud hosted or hosted locally; the Guildhall Art Gallery originally used a cloud solution for hosting but later switched to local hosting to lower the CMS costs (Alexandra Walker and Nancy Wade, personal communication, March 11, 2021).

Terri Dendy from the National Army Museum gave us insights into the usefulness of flexible hosting during our conversation with her. The National Army Museum's CMS is a homemade, locally-hosted CMS, but they are considering the possibility of switching to a cloud-based hosting solution to make remote logins easier (Terri Dendy, personal communication, March 22, 2021). Both the National Army Museum and the Guildhall Art Gallery reap the benefits of flexible hosting, though their individual needs are different.

User Training

From both institutions, we learned that training is not as straightforward as expected and that a long timeline can be expected before users are comfortable with the CMS. At both the Guildhall Art Gallery and National Army Museum, training was a key consideration for implementing a CMS. During our key informant interview with the Guildhall Art Gallery, Alex and Nancy shared their experience with CMS training: at the gallery, training was a long process that took roughly two years and involved a continuous cycle of learning. We also learned about the approach used at the National Army Museum for training: roughly 20% of the museum's CMS users were designated as superusers, people who use the system often and have received extensive training. These superusers were later utilized as a resource to informally train their peers.

Key Features for a Spectrum-Compliant CMS

Terri Dendy gave us insights on which CMS features are important for her work, emphasizing the importance of Spectrum compliance. This echoed a major conclusion from our background research: you need to be Spectrum compliant to be an accredited museum in the UK. In terms of workflows within the CMS, she highlighted Accessioning and Object Entry as the most important Spectrum processes that Tower Bridge's CMS should implement properly. Accessioning refers to recording the addition of a new item to a museum collection, and Object Entry refers to creating a new object record in the database. To prove Spectrum compliance, Tower Bridge will have to demonstrate these procedures and provide written documentation for them.

Assessing Tower Bridge's Expectations for a CMS

We received nine total responses for our survey on the 40 important criteria for a CMS. Although Dirk Bennett assured us that different teams at Tower Bridge were represented by the response, our findings from this survey may have been limited by this sample size. Our team decided that a score of 4.5 out of 5 or higher was an important criterion for Tower Bridge because a threshold lower than 4.5 would have yielded too many features to prioritize. The highest priority criteria were: Accessioning, Inventory, Security, Location and Movement Control, Cataloguing, Object Entry, Management and Documentation of collections, and Backups (refer to the green bars on Figure 9). This survey validated the insight we got from Terri because the Tower Bridge team also prioritized Accessioning and Object Entry as features they believe are important.

We were also able to identify several criteria that were not important to Tower Bridge. For example, the survey results showed Object Exit, the process of documenting when assets leave the institution, was not a priority for our survey respondents (refer to the purple bar in Figure 10). Spectrum standards include Object Exit as a primary procedure, but through our interviews with Dirk, we realized Tower Bridge assets rarely depart from the collection (Dirk Bennett, personal communication, 2021). This also confirms Terri Dendy's recommendation that Tower Bridge focus on certain procedures (Accessioning and Object Entry) first, and when staff has more time, they can proceed to implement and document the other seven primary Spectrum procedures.

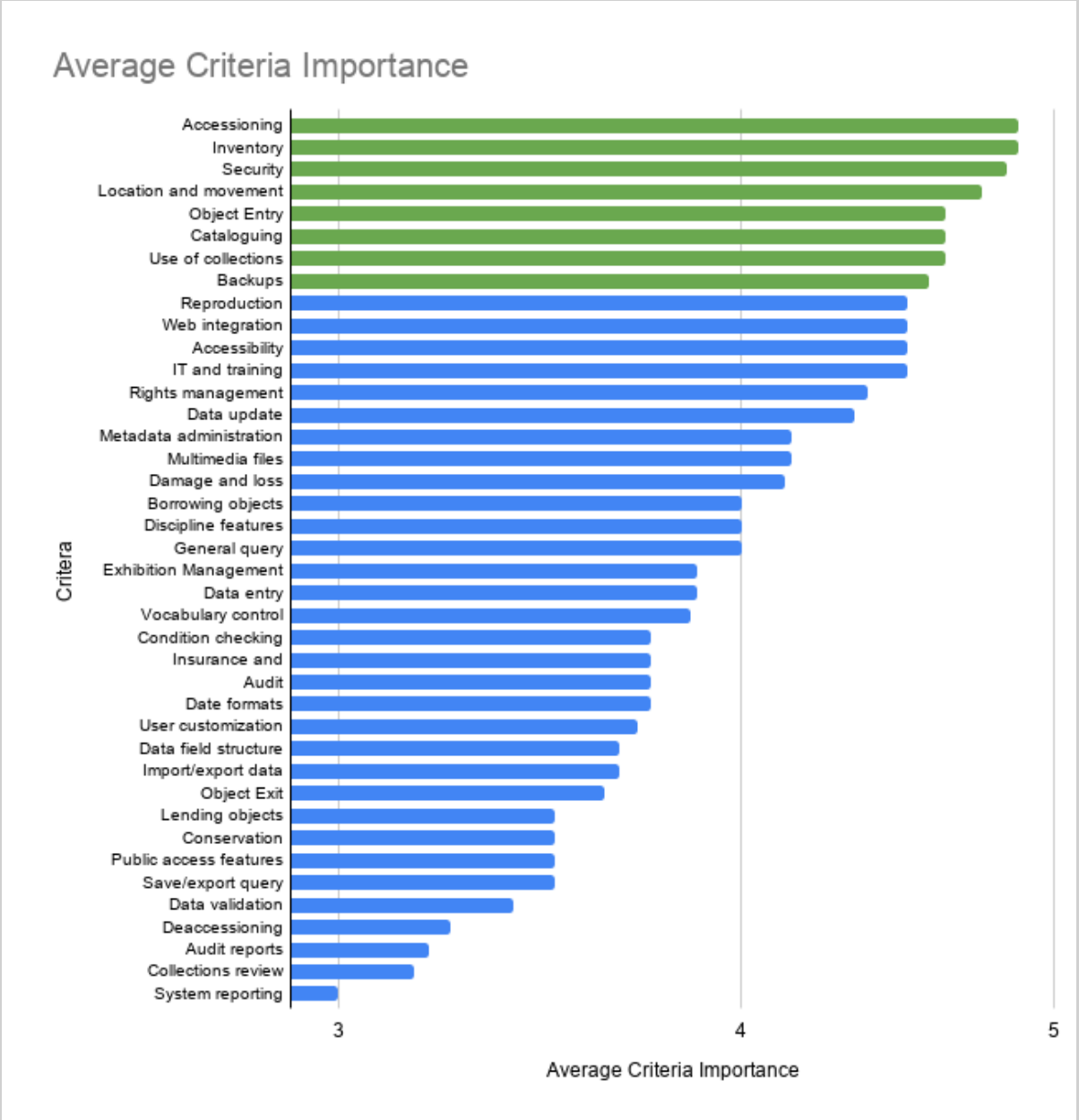


Figure 9: The average importance, recorded on a scale of one to five, for 40 criteria from the CHIN abbreviated checklist

Developing a List of Criteria for CMS Evaluation

To develop our criteria for the CMS options, we used an iterative design that was revised through feedback from Dirk Bennett and the project advisors. The project team finally arrived at a list of six criteria:

1. **Layout & Ease of use** *(How easy is the system to use and is the user interface visually appealing?)*
2. **Scalability & Future uses** *(How feasible is it to improve the system and make modifications?)*
3. **Scope & Fitness** *(How well does the system fit the needs of Tower Bridge, and does the system have the features needed?)*
4. **Maintenance & Support** *(How easy is it to get external technical maintenance for the system, and is the support cost-effective?)*
5. **Searching** *(Does the system have robust search capabilities, including an advanced search and ways to see thumbnails of images in the search results?)*
6. **User groups & permissions** *(Does the system allow administrators to control who has access to assets, and can the permissions be changed?)*

When we began evaluating potential CMS options, the team initially came up with 3 criteria to use across all systems: Visualizing Search Results (Are image thumbnails shown in the search results?), Complexity (How complex is the system and its features?), and Layout/Ease of use (How easy is it for new users to find the important buttons and taskbars?). After presenting our initial assessment of the CMS options concerning these three criteria, Dirk Bennett suggested expanding the list to a total of five or six criteria. He provided suggestions for criteria we should add to our analysis, including "maintenance/upkeep, security, scalability/future uses" (Dirk Bennett, e-mail, 2021).

After our first few demos with CMS vendors, the project team decided to generalize the criteria "Visualizing Search Results" to "Searching. This allowed our analysis to continue considering search visualization while also considering the complexity and effectiveness of the basic and advanced search features within each CMS; "Searching" was then more broadly defined as the ability to conduct, view, and save queries. Discussions with our project advisors led us to eliminate "Complexity" from the list since our evaluations were effectively the inverse of "Ease of use".

Additionally, we chose not to include security in our final criteria list since the CMS vendors had not shared much about their encryption and security standards during our meetings. Instead, we included "User groups and permissions" as a reflection of our research. This criterion reflects the fact that "A good CMS will allow whoever is designated as the person in charge of the software to define levels of security on both a group and individual level" (Sully, 2006). The User groups & permissions criteria allowed us to analyze how well each CMS implements this functionality. These six criteria created a unified structure for our project team to compare systems in detail.

Identifying and Filtering Out Systems that are Suitable for Tower Bridge

Given the potential options, we then narrowed the list down progressively by identifying the key features of each system and comparing them to Tower Bridge's needs. This was done using interviews with peer institutions, online resources like the Collections Trust and CHIN, and conversations with Dirk Bennett and other staff at Tower Bridge.

Interviewing peer institutions helped to identify systems through direct recommendations. The Guildhall Art Gallery strongly recommended their system, CollectionsIndex+, developed by System Simulation (SSL) (Alexandra Walker and Nancy Wade, personal communication, March 11, 2021). SSL has the ability to provide customer service tailored to each client, as was praised by Nancy and Alex at the Guildhall Art Gallery. As a company, SSL seems to prioritize having good relationships with its customers, as they were able to develop new conservation features for the Guildhall Art Gallery. Amy Smid, the WPI archivist, also provided a direct recommendation for CollectionSpace, an open-source software that can be used by museum professionals (Amy Smid, personal communication, March 5, 2021). Although Amy's experience was more in archive software, her direct recommendation gave us a starting point to investigate non-traditional CMS options.

Interviewing peer institutions also helped us gain insight into the various types of CMS out there, including building one yourself and open source systems. The National Army Museum uses a system they made in-house (Terri Dendy, personal communication, March 22, 2021). Terri confirmed Annamaria Poma Swank's statement that an in-house system would not be ideal for a small institution, like Tower Bridge, by elaborating on the high level of IT resources required to run the system (2008). Amy Smid uses the open-source software ArchiveSpace (Amy Smid, personal communication, March 5, 2021), however, we concluded that it would not be a good fit for Tower Bridge because it is oriented towards archiving rather than museum use and requires a lot of IT resources to implement. From these two key informant interviews, our team found that investigating commercial CMS options would be more worthwhile for Tower Bridge.

Online resources, such as the Collections Trust and CHIN, were valuable resources in identifying viable commercial systems. The Collections Trust offers bullet point style summaries of many different systems, including those that are partners with their standards, Spectrum, and some that are not. Additionally CHIN offers detailed, though sometimes outdated, profiles on different vendors and their systems including a comparison to the CMSCC that was mentioned earlier in the background.

These sources allowed us to begin compiling a list of CMS options in a spreadsheet including details on the systems in an abbreviated format. This was done to aggregate all the most relevant information into a convenient location to facilitate comparisons between the systems. An example from that spreadsheet is visible in Figure 10. The full spreadsheet can be seen in Appendix I.

Option	Vendor Website	CHIN Review	Collections Trust Description	Storage Hosting Solution	Software Type	Spectrum Compliant	Key Features	Cost	Demonstration Status	Summary	Top Choice
Proficio	Website	Review	Description	Local or Cloud	Web browser	Yes	Unlimited Users Each user gets their own login credentials and permissions Highly customizable Easy search & data entry Designed for easy user interaction and expedited workflow Different libraries (art, history, archives)	**205 USD monthly / £1780 annually** for Proficio Elements (*Cloud*) 5 concurrent users, 100GB storage limit 10 USD/month for each additional 50GB **2475 USD / £1790** (one-time) for Proficio Elements (*Local*) licence 5 concurrent user sessions	Demo done on 3/29, steps for logging into the online demo are linked here: link	Affordable option that may have a large learning curve	Yes

Figure 10: A sample system from the CMS options spreadsheet

Our project team identified the following twelve CMS options: Proficio Elements, CollectiveAccess, TMS Cataloguer, Axiell Collections, CollectionsIndex+, PastPerfect Web, CollectionSpace, Argus, Collector Systems, Coeli, eHive, and Catalogit. We eliminated all that were not Spectrum compliant, as shown in Figure 11, except for CollectiveAccess. CollectiveAccess was kept in our shortlist to act as a point of comparison and to represent open-source software, as while it cannot call itself Spectrum compliant it can be configured to meet Spectrum standards.

Spectrum Compliant	Not Spectrum Compliant
1. Proficio Elements	1. CollectiveAccess (by default)
2. TMS Cataloguer	2. PastPerfect Web
3. Axiell Collections	3. CollectionSpace
4. CollectionsIndex+	4. Argus
5. Collector Systems	5. eHive
6. Coeli	6. Catalogit

Figure 11: Comparing Spectrum Compliance

Collector Systems was eliminated due to its focus being more on physical artifacts. They focus mostly on condition checking and other functions important to a physical collection, but Tower Bridge's collection is mostly images or scanned-in documents. Thus, a more well-rounded system that can meet its individual needs would be a better option. The remaining system that was eliminated from our shortlist, Coeli, was eliminated due to being desktop-based software which is harder to gain access to. Dirk Bennett and Adrian Dressekie later corroborated this decision by asking us to rule out desktop-based software to allow people to work remotely with the system. This only left five systems to look at going forward:

Shortlist of CMS Options
1. TMS Cataloguer
2. CollectionsIndex+
3. CollectiveAccess
4. Axiell Collections
5. Proficio Elements

Project Team's In-depth Analysis into Potential Systems

In this section, we present our results from a thorough investigation into the five remaining systems. We focused our research on the 6 CMS criteria we identified as being the most important to Tower Bridge: Scalability & Future uses, Scope & Fitness, Maintenance & Support, Searching, and User groups & permissions. Our findings were based on information gathered during live demonstrations, interviews with system representatives, and our personal use of demo software. Below is an in-depth summary of how well each of the 5 CMS options met the 6 previously mentioned criteria.

TMS Cataloguer

TMS Cataloguer had a well-designed, modern, user interface with a layout centered around a dashboard on the home screen to allow quick access to key features such as searching, adding records, batch editing, and location tracking (Figure 12). There are 3 options to view search results: object entry view, lightbox (thumbnail view), and list view, which provide great visualization of results. The search feature contained a basic search and an advanced search consisting of several easy-to-use filters. Most notable was how easy it was to display, save, and retrieve search results. Looking at user groups and permissions, we found that user groups can be set for permissions for read, read/write, and admin access levels. The user groups can also be limited in quality and access for viewing and downloading images for certain assets. For future expansion, additional modules can be added for conservation, digital asset management, and public access. Support representatives are available in the UK, but the company is based in the US. There is little system maintenance as the software is web-based. This allows all updates to be done online by the service provider. For additional support, there is a help button present in the system. Although the system contains many features, they would probably not be utilized by Tower Bridge staff, therefore the complexity of the system is too much for Tower Bridge.

CollectionsIndex+

Similar to TMS Cataloguer, the layout for CollectionsIndex+ is centered around a dashboard that allows easy access to the database, terminology control, and user groups and permissions, shown in Figure 13. Also, the layout for individual assets automatically hides empty fields to reduce clutter. The user interface is simplistic and to the point without the flashy graphical design that systems such as TMS Cataloguer use. The search engine had a basic quick search and an easy, yet robust, advanced search with numerous fields to choose from that can also accept ranges. There were two views for the results: a list view, which shows descriptions and thumbnails, and a grid view of thumbnails alone. Additionally, the advanced search feature has several options for sorting the results such as hierarchical order or recently modified. There are 4 user groups in the system: Admin, Read/Write, Read, and Restricted. Administrators have exclusive control over authorities and user groupings. SSL provides several add-on modules. Most notable are Extended Media, which allows the system to ingest a slew of different media formats, and AssetIndex+, which gives full DAM functionality to the system and is compliant with the Spectrum DAM procedures. SSL also provides the option to host a public-facing website through CollectionsOnline. They offer London-based user support and paid training. Additionally, they have a good reputation for forming long-term relationships with their clients (Alexandra Walker and Nancy Wade, personal communication, March 11, 2021). The modular system that SSL offers allows the system to be sized so the system is not cluttered with unnecessary features. CollectionsIndex+ with AssetIndex+ is a good fit for an institution such as Tower Bridge.

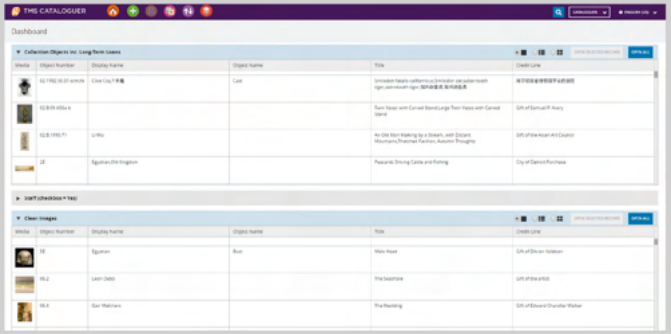


Figure 12: TMS Cataloguer Dashboard

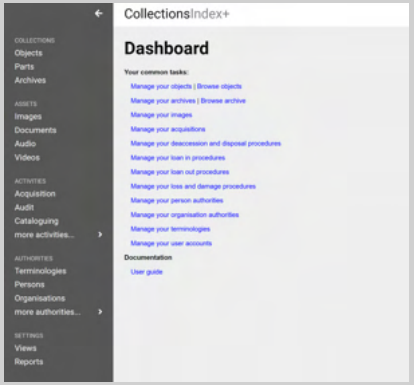


Figure 13: CollectionsIndex+ Dashboard

Collective Access

CollectiveAccess was the only open-source software that was considered. The following findings were based on the novastory_config profile developed for NovaMuse as it was the best fit for Tower Bridge. The system had a very simple and concise user interface that was effective and easy to use. The layout had a central dashboard with important information and tabs at the top for object entry, object searching, administration/preferences, and history (Figure 14). The search feature consisted of a generic basic search and a simple advanced search that allows for searching specific data fields. Similar to TMS Cataloguer, the results had three views: spreadsheet view (Figure 15), thumbnail view, and image view. Being open-source, the system had an extremely extensive user group and permissions setup. There is an unlimited number of groups that can be created and every aspect of the database can be set to read/write, read, or no access for each group. On the downside, the system offers no add-on modules. The software is intended to be completely set up before implementing it, and making changes to the system becomes very difficult after objects have been entered into the database. For support, the system would have to be maintained and set up by Tower Bridge staff and requires programming knowledge. There is paid support through Whirl-i-Gig; however, it is very expensive and is intended as an aid as opposed to a full support system. Confirming our background research on implementing open-source systems, we found from our interview with a representative of Whirl-I-Gig that the high level of customization that CollectiveAccess offers is not a good fit for Tower Bridge.

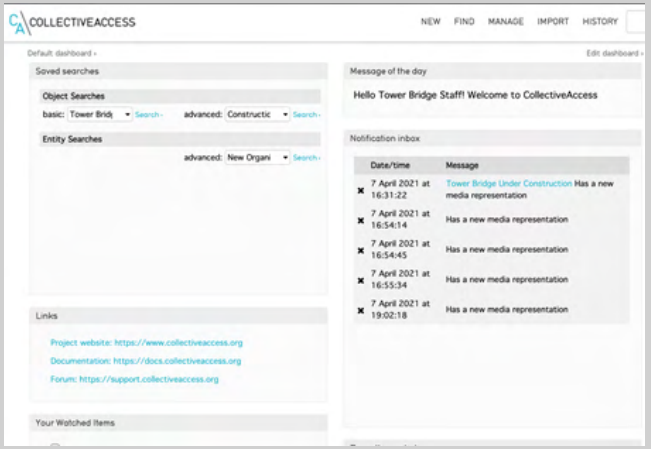


Figure 14: CollectiveAccess Dashboard

Open-source software has a reputation for being highly customizable, which was very enticing as we were identifying potential systems for Tower Bridge and led us to favor CollectiveAccess as an option. However, when we met with Seth Kaufman from Whirl-I-Gig, he informed us that the level of customization provided by open-source software is a negative for Tower Bridge (Personal communication, March 29, 2021). He explained that a small institution such as Tower Bridge would most likely not have the resources or time to utilize the customization provided by the software. Typically, institutions will spend years setting up open-source software and require an IT department to develop, update, and maintain the system. Additionally, this level of customization is overkill for a small institution and would only result in overcomplicating the system. These findings led us to reconsider open-source CMS options and how they would be utilized by Tower Bridge.

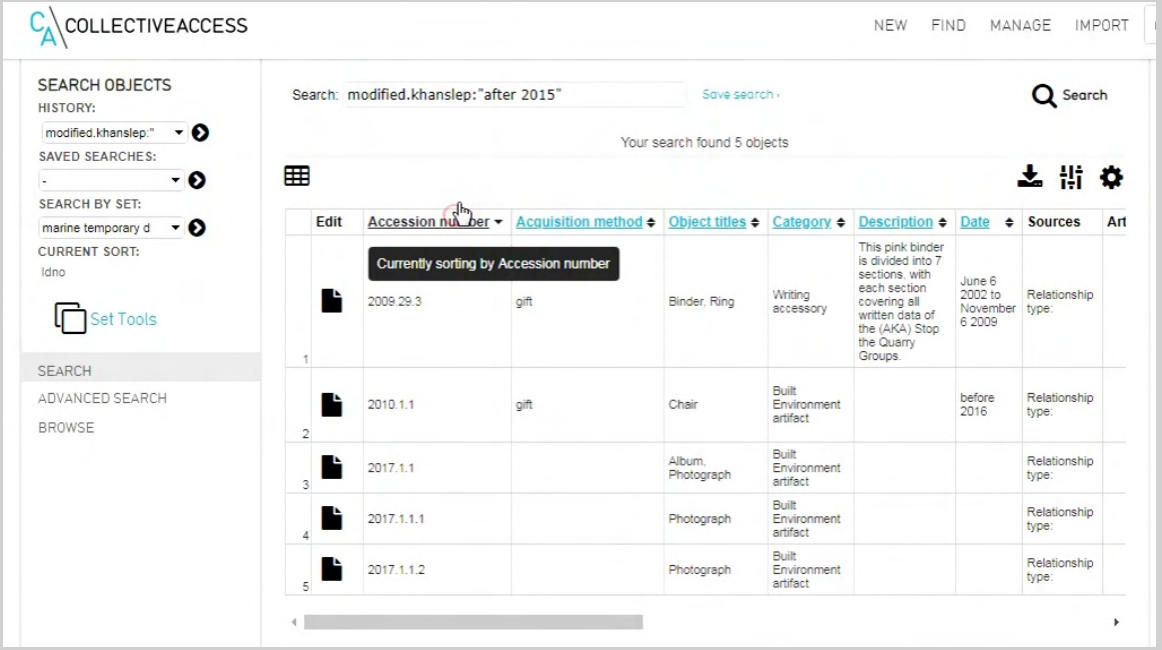


Figure 15: Spreadsheet view for search results in CollectiveAccess

Axiell Collections

Axiell Collections had one of the most impressive user interfaces and layout. The user interface was attractive and modern-looking while also being concise and easy to follow (Figure 16). The layout consisted of many different screens that you can choose from a tab at the top. The most notable screens are record details, hierarchical view, related records, and media viewer which can either be viewed on their own or side by side. Their search feature is complex but robust with the basic search looking more like a typical advanced search and the advanced search implementing a programming style logic to create a search request. Multiple screens for the search results such as record details view, list view, or gallery (thumbnail) view can be displayed side by side or by themselves. Being able to see multiple result screens at once is a huge benefit for multitasking. Administrators can set user permissions between None, Read, Read-Write, and Full on any level from the individual data field to objects in general. Additionally, it offers system usage tracking by showing how long and from what IP logins are in use. There are three major modules that can be combined in any way: Museum, best suited for managing a variety of items, Archive, tailored towards archive collections, and Library, designed for library use. Additionally, Axiell offers a public access module. Within the system, there is a generic help feature, providing information on what a field expects, and a FAQ section. Additionally, paid support can be reached through the FAQ section that is based in the EU. This system is a good fit for an institution such as Tower Bridge. It is not over complicated with unnecessary features, and it is robust enough to handle most if not all of Tower Bridge's needs. The main downside is that the search feature is too complex for Tower Bridge.

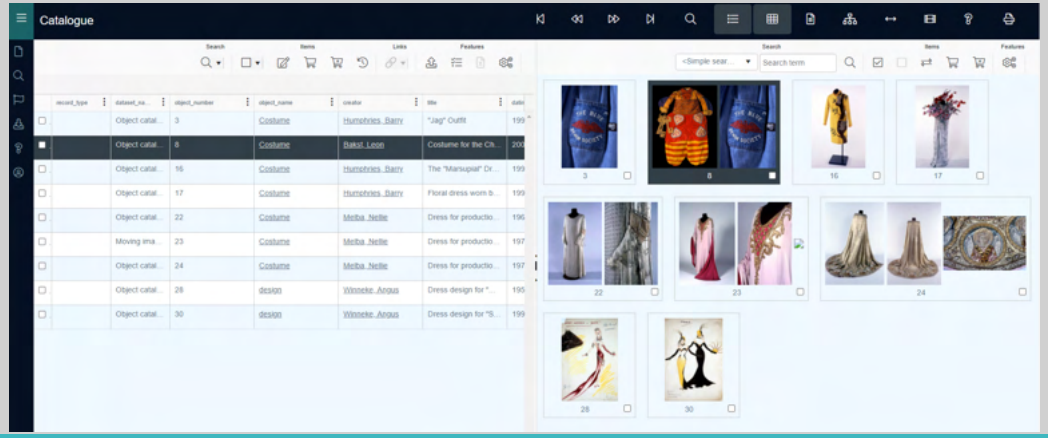


Figure 16: Axiell Collections

Proficio Elements

The last system we evaluated is Proficio Elements. Proficio had a hierarchical layout that can be accessed through a toolbar on the side of the screen. The layout itself is not overly complicated, however, the outdated user interface makes the system difficult to navigate as seen in Figure 17. In addition to the poor user interface, the system has a bad search feature that is difficult to find and a complicated advanced search that only supports specific data field searching. The main view for the search results is a list view that does not contain thumbnails when doing an advanced search across libraries. When doing the basic search, you can choose to filter for objects with images or open up a thumbnail view in a separate screen to help with visualization. Admins can set up unique user or group settings for edit or read-only access. In regards to restricting access, only libraries as a whole can be restricted to certain users. The system does offer extensive user tracking on when users are logged in and who made recent changes which can be viewed by the admin. Proficio Elements can be easily updated to full Proficio at any time which allows for unlimited libraries. Additionally, there is a public access module for creating a website. There is an extensive support system that consists of a basic help button within the system, online videos for training, live webinars hosted monthly, and paid US-based support. For Tower Bridge, Proficio has the bare necessities to meet their requirements but no additional features that allow it to stand out.

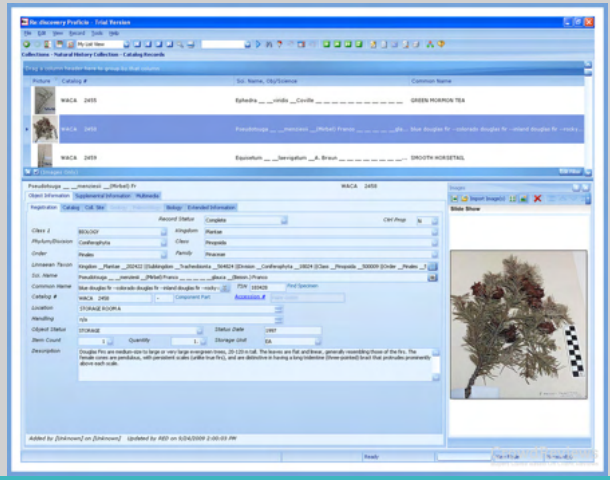


Figure 17: Proficio Elements

Using Input from Tower Bridge Staff to Recommend a CMS

Surveying Tower Bridge Staff's Opinions on the Important Criteria for a Collections Management System

We developed a live presentation that staff could attend and present feedback for as they learned about the CMS options presented. In addition to our main sponsor Dirk Bennett and the Head of Tower Bridge Chris Earlie, the staff surveyed included members of the Tower Bridge departments of exhibition, marketing, learning, and IT. During this presentation, a shortlist of 5 options were presented: Proficio Elements, CollectiveAccess, TMS Cataloguer, Axiell Collections, and CollectionsIndex+.

Discussion of the Criteria Scores from Tower Bridge Staff

As can be seen from Figure 18, for Layout & Ease of use, the most highly weighted criterion, Proficio had the lowest perceived ease of use at 4.5, which caused Proficio's final score to suffer. The scores for the 4 other systems were significantly higher, with CollectiveAccess, TMS Cataloguer, and CollectionsIndex+ having scores between 7 and 8 and Axiell Collections having the highest ease of use at 8.3.

For Scalability & Future uses, CollectiveAccess was the lowest-rated with a score of 3.8, most notably due to the perception that its open-source nature would make it difficult to expand and modify in the future. The scores for the other 4 systems ranged between 7 and 8, with CollectionsIndex+ receiving the highest scalability score at 8.0.

The results for Scope & Fitness were more varied, with CollectiveAccess scoring lowest at 4.9 and Axiell Collections and CollectionsIndex+ tied with a score of 7.5 as the highest. CollectiveAccess most likely had the lowest score in this category because of its open-source nature, making it more difficult to envision as a robust product that fit Tower Bridge's needs, while more established systems such as Axiell Collections and CollectionsIndex+ had features that showed their relevance and demonstrated use in a museum environment. TMS Cataloguer (with a score of 6.4) had a more complex set of features, while Proficio (with a score of 5.9) had a more complex organizational structure. Respondents likely rated Axiell Collections and CollectionsIndex+ higher because of their lack of superfluous features and simplified organization.

For Maintenance & Support, CollectiveAccess scored the lowest at 2.5, as the open-source software was perceived as difficult to maintain, a fact that was previously discovered from our background research into the types of collections management systems (Ameli, 2008). CollectiveAccess's status as a non-commercial software meant it would require a high degree of technical competence for Tower Bridge staff to keep the system running unless expensive external support was contracted. CollectionsIndex+ received the highest maintenance & support rating with a score of 8.0, most likely because of its demonstrated use in other London institutions such as the Guildhall Art Gallery, which had a successful support partnership with the vendor (Nancy Wade, personal communication, March 11, 2021).

	Layout & Ease of use	Scalability & Future uses	Scope & Fitness	Maintenance & Support	Searching	User groups & permissions	Total Score	Spectrum Compliant	Price
Weight (1-100)	**90**	**80**	**70**	**60**	**50**	**50**			
Proficio	4.5	7.0	5.9	5.9	5.0	6.9	2323	Yes	£1800 annually
CollectiveAccess	7.9	3.8	4.9	2.5	8.0	7.1	2256	No	£1500 annually
TMS Cataloguer	7.0	7.5	6.4	7.4	8.0	7.5	2894	Yes	£8700 annually
Axiell Collections	8.3	7.8	7.5	7.4	7.1	8.0	3086	Yes	£6700 annually
CollectionsIndex+	7.9	8.0	7.5	8.0	8.3	8.1	3173	Yes	£9900 one-time + £3000 annually

Figure 18: Weighted Value Analysis determined from the survey given to Tower Bridge staff

This could be a limitation with our findings, as Tower Bridge staff would be slightly biased towards a product that they know colleagues have used successfully. Proficio, TMS Cataloguer, and Axiell Collections all had scores that demonstrated their perception as systems with adequate but not exceptional support services which corroborated our previous research.

Searching was lowest for Proficio with a score of 5.0, as its advanced search features were not as robust as the other systems that had scores near 7 to 8. CollectionsIndex+ received the highest score for searching at 8.3, and its search was bolstered with the use of archive hierarchy and authority control, which in practice made it an excellent option for search capabilities.

User groups & permissions was the last category surveyed, with many of the scores around the same range. Proficio was the lowest with a score of 6.9, and CollectionsIndex+ had the highest user group score at 8.1 due to its effective set of predefined user groups as well as its ability to customize the properties of user groups if needed. It was somewhat difficult to describe and show all the user control features to Tower Bridge staff in the limited time for the presentation, but the survey results showed a generally positive view of the systems' ability to control who had access to the assets and what permissions could be controlled.

Overall Analysis of the CMS Options Presented

The results from Tower Bridge's Weighted Value Analysis can be seen visually in Figure 19. From these results, the lowest-ranked system based on Tower Bridge staff's perception was CollectiveAccess, with a total weighted score of 2256. Due to its status as open-source software, CollectiveAccess required compromises to be made in terms of the soundness of the system.

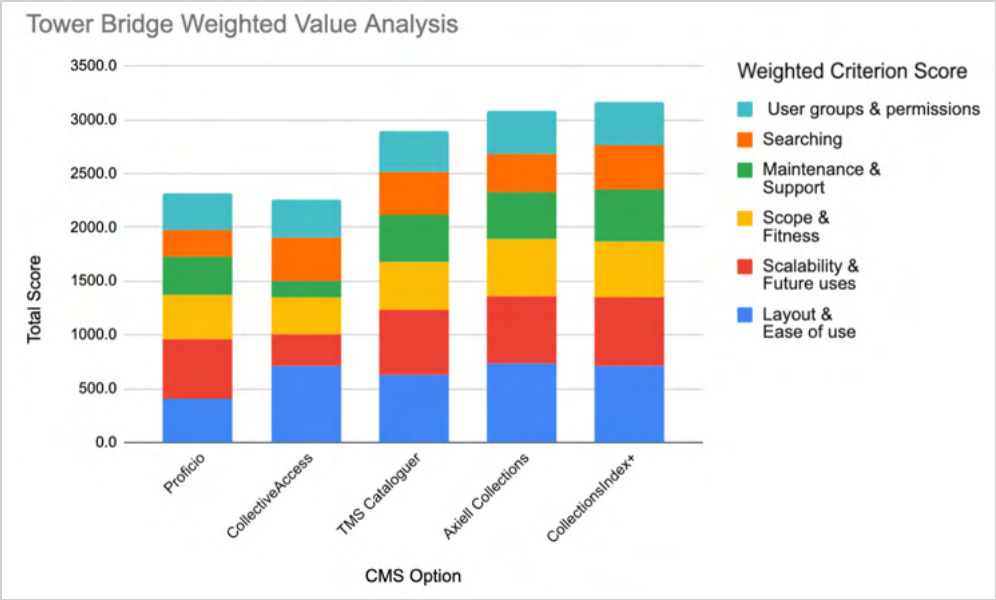


Figure 19: Visual representation of the Weighted Value Analysis determined from the survey given to Tower Bridge staff

Although customization could be a benefit for institutions looking to develop a CMS, the high degree of technical competence and investment required to set up the system and make changes led to CollectiveAccess receiving low scores. The survey results corroborated our research in the background chapter that described how increased commitments required by open-source software are seen negatively by users (*What Is Open Source?*, n.d.). Despite its good scores in the Layout & Ease of use and Searching criteria, CollectiveAccess was not a feasible option because of its lack of external support to ensure the system performed as needed; Tower Bridge being responsible for extensive set-up and maintenance was undesirable.

The three middle options showed some differences among the high-scoring categories. Proficio was ranked the second-lowest system with a total weighted score of 2323. Although its functionality was comparable to more highly rated systems, Proficio's low scores in Layout & Ease of use and Searching hurt the system's final score. This upheld our findings from the background chapter, most notably that poorly designed graphical user interfaces can hinder the ability of museum staff to perform tasks (Ménard et al., 2010). TMS Cataloguer was ranked in the middle of the options presented, with a final weighted score of 2894. TMS Cataloguer suffered most in the scope & fitness criterion due to its inclusion of features that Tower Bridge staff would probably consider extraneous and have no need for. Axiell Collections was ranked as the second-highest system with a total weighted score of 3086, having good scores across the board. Axiell's score for layout & ease of use was the highest out of all systems, but its search functionality was not as highly scored as some of the other systems.

CollectionsIndex+ showed high scores in all the criteria surveyed, and its final weighted score of 3173 made it the top choice from the weighted value analysis done by Tower Bridge staff. CollectionsIndex+ received the highest scores in 5 out of the 6 criteria (Scalability & Future uses, Scope & Fitness, Maintenance & Support, Searching, and User groups & permissions) and the second-highest score in the Layout & Ease of use criterion. Overall, it appears Tower Bridge staff were impressed with the system's capabilities, and having demonstrated use in other London museums could have helped its perception as a feasible system.

WPI Weighted Value Analysis Showed Similar Results

In addition to the survey results from Tower Bridge's staff, the results from the WPI team's review confirmed the Tower Bridge staff's scoring for systems, as shown in Figure 20. The final weighted scores from the WPI team showed that CollectionsIndex+ was the most suitable choice for a CMS at Tower Bridge, having similar results to the Tower Bridge staff's survey results and coming highest in 5 out of the 6 criteria. Like Tower Bridge staff, the WPI team scored Axiell Collections second-highest and TMS Cataloguer third-highest. In contrast to the Tower Bridge team, the WPI team had CollectiveAccess more highly ranked than Proficio. Because the WPI team was more technically-minded, we were more enthusiastic about the potential of open-source software and did not have comparable qualms as the Tower Bridge team about the difficulty of developing a robust CMS. However, both the WPI team and the Tower Bridge team had similar negative views of Proficio's layout & ease of use.

	Layout & Ease of use	Scalability & Future uses	Scope & Fitness	Maintenance & Support	Searching	User groups & permissions	Total Score	Spectrum Compliant	Price
Weight (1-100)	**90**	**80**	**70**	**60**	**50**	**50**			
Proficio	3	6	7	8	4	9	2370	Yes	£1800 annually
CollectiveAccess	8	6	8	2	9	7	2680	No	£1500 annually
TMS Cataloguer	8	8	7	6	9	5	2910	Yes	£8700 annually
Axiell Collections	7	7	9	7	8	6	2940	Yes	£6700 annually
CollectionsIndex+	7	9	9	8	9	8	3310	Yes	£9900 one-time + £3000 annually

Figure 20: Weighted Value Analysis from the WPI team

Additional Considerations for CMS Options

Although the final scoring from the weighted value analyses done by both the Tower Bridge staff and WPI teams showed CollectionsIndex+ as the most suitable option, other factors still had to be considered before Tower Bridge could make a final decision, as shown in Figure 21. Spectrum standards must be followed by UK museums, and Tower Bridge's impending application for museum status led them to consider Spectrum compliance of the CMS to be a critical factor in the decision. In addition to having the lowest weighted score, CollectiveAccess was not Spectrum compliant and was eliminated from contention due to this. The other four systems were all Spectrum compliant but had varying prices that would affect their potential use at Tower Bridge. TMS Cataloguer was the most expensive out of the remaining options, with an approximate annual cost of £8700, making it hard to keep in contention while only being the third-highest option out of the four remaining Spectrum compliant systems. Proficio's cost was much lower than the other systems but was not in serious contention due to its very low score in the highly-weighted Layout & Ease of use criterion. CollectionsIndex+ and Axiell Collections remained as the two most highly favored options for Tower Bridge, and investigating more about the configurations and exact costs for additional features was the next step our team had to research.

	Total Score	Spectrum Compliant	Price
Weight (1-100)			
Proficio	2323	Yes	£1800 annually
CollectiveAccess	2256	No	£1500 annually
TMS Cataloguer	2894	Yes	£8700 annually
Axiell Collections	3086	Yes	£6700 annually
CollectionsIndex+	3173	Yes	£9900 one-time + £3000 annually

Figure 21: Final scores from the Weighted Value Analysis determined from the survey to Tower Bridge staff with Additional Considerations

	Summary	Users	Installation	Cloud hosting			One-off pricing for license				
			set-up	license per year	*ie license per year per user*	add. license	license one-off	*add.cost*	total licence one-off + add.cost	*license per user*	add. license
CollectionsIndex+ with Extended Media	100GB Ext. Media allows audiovisual media, PDF etc.	4	£375	£2,000	*£500*	n/a	£5,000	*£1,500 (Extended Media) £1,500 (Office Export for reports) £tbc (data transfer)*	£8,000	*£2,000*	£350
CollectionsIndex+ with Asset Index+	100GB AssetIndex+ allows full media functionality	4	£375	£2,000	*£500*	n/a	£5,000	*£5,000 (AssetIndex+) £1,500 (Office Export for reports) £tbc (data transfer)*	£11,500	*£2,875*	£350
Axiell Collections	100GB media functionality Import/export	5	£900	£6,700	*£1,340*	£6,700 Purchased in batches of 5	n/a		n/a	*n/a*	n/a

Figure 22: Cost Comparison for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections

Cost Comparison of CollectionsIndex+ and Axiell Collections

Between the two highest-scoring systems, CollectionsIndex+ and Axiell Collections, a significant consideration was the price difference. The two systems followed vastly different pricing models, with CollectionsIndex+ having a higher cost associated with one-off costs for the initial licensing, and Axiell having higher costs for the annual cost of system operation. As can be seen in Figure 22, Axiell Collections had no one-off costs associated with the licensing, but CollectionsIndex+ had significantly more options and costs for one-off costs. Although many collections management systems allow for the storage of audiovisual material by default, CollectionsIndex+ does not include this functionality in its base package. From our discussion with representatives at SSL, we determined there were two potential setups for CollectionsIndex+ that would meet Tower Bridge's need to store multimedia such as video and audio, either the Extended Media or AssetIndex+ add-on modules.

AssetIndex+ is a digital asset management (DAM) system, which can act as a standalone management system for digital media and can be used independently of CollectionsIndex+. CollectionsIndex+ can add the functionality of AssetIndex+ to combine the two systems, which is what we have been considering, but AssetIndex+ is also robust enough to stand alone and manage digital assets (including documentation and searching) independently of objects in the collection.

On the other hand, Extended Media, an alternative to AssetIndex+, does not provide any other management capabilities to CollectionsIndex+. Extended Media allows you to attach additional types of multimedia (audio, video, etc.) to objects in the database, but does not provide ways for you to manage those digital assets independently of the object. Both AssetIndex+ and Extended Media have similar media compatibility, but the difference is in the management capabilities.

The cumulative cost comparison in Figure 23 shows a price comparison for the two configurations for CollectionsIndex+ (one with the Extended Media module and the other with AssetIndex+) and Axiell Collections over 3 years with no support and training. Comparing the two CollectionsIndex+ options with the standard Axiell Collections configuration reveals that although the up-front costs would be greater for CollectionsIndex+, it would be cheaper than Axiell Collections after 3 years, with Axiell Collections having a fixed annual rate of £6700 and CollectionsIndex+ having a fixed annual rate of £2000.

The differences between additional costs are less significant, but also something that was considered as Tower Bridge made their final decision. For example, as can be seen in Figure 24, CollectionsIndex+ has no associated cost with setting up a website for public access to assets in the database but has a higher annual cost for the hosting and maintenance of the website.

Making a Final Decision on the CMS to Choose

From discussions with Dirk Bennett and input from the rest of his team, Tower Bridge chose to move forward with CollectionsIndex+ as its CMS. CollectionsIndex+ scored highest in both the WPI team and Tower Bridge's weighted value analyses, and even though the initial setup costs would be greater than Axiell Collections, the system would be less expensive after 3 years.

			Installation	Cloud hosting	One-off pricing for license	Cumulative Cost		
	Summary	Users	set-up	license per year	total licence one-off + add.cost	Cost after 1 year	Cost after 2 years	Cost after 3 years
CollectionsIndex+ with Extended Media	100GB Ext. Media allows audiovisual media, PDF etc.	4	£375	£2,000	£8,000	£10,375	£12,375	**£14,375**
CollectionsIndex+ with Asset Index+	100GB AssetIndex+ allows full media functionality	4	£375	£2,000	£11,500	£13,875	£15,875	**£17,875**
Axiell Collections	100GB media functionality Import/export	5	£900	£6,700	n/a	£7,600	£14,300	**£21,000**

Figure 23: Cumulative Cost Comparison for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections

			Additional Costs			Public Access	
	Summary	Users	configuration to Spectrum standards	training	support	public access per year	setup for public facing side
CollectionsIndex+ with Extended Media	100GB Ext. Media allows audiovisual media, PDF etc.	4	£750	£750	15% of contract value	£3,000	n/a
CollectionsIndex+ with Asset Index+	100GB AssetIndex+ allows full media functionality	4	£750	£750	15% of contract value	£3,000	n/a
Axiell Collections	100GB media functionality Import/export	5	n/a	£1300 for 8 people	See Appendix J for rates	£2,500	£1,350

Figure 24: Additional Costs for CollectionsIndex+ with Extended Media, CollectionsIndex+ with AssetIndex+, and Axiell Collections

Tower Bridge also decided to move forward with the CollectionsIndex+ option that included AssetIndex+. Although AssetIndex+ was the more expensive module, Tower Bridge staff felt that it matched their needs of having objects as just digital assets rather than being constrained to objects. Our research and surveying of Tower Bridge staff culminated in the final decision of CollectionsIndex+, but more investigation was required in determining the most suitable configuration for Tower Bridge.

Implementing CollectionsIndex+ for Tower Bridge

Once the Tower Bridge team confirmed CollectionsIndex+ as the preferred CMS, we discovered more about how it could be implemented. Because the installation of the system is managed by SSL, we conducted additional interviews with representatives to investigate more about the set-up process and customization options.

Using the CollectionsIndex+ Demo

Having access to an online demo of CollectionsIndex+ allowed us to verify that sample assets provided by Tower Bridge could be stored and cataloged within CollectionsIndex+. Our demo included AssetIndex+, which allowed us to see how digital asset management could work with the Tower Bridge collection. We were able to upload the asset to the DAM portion of the system (AssetIndex+) and catalog information on the rights and copyright status for the digital media. From the Archive section in the main CollectionsIndex+, we began inputting cataloging information on the asset such as the title, description, date, and a few other basic fields. We discovered that explanations and examples for data fields can be found using a help function, shown in Figure 25. For this data entry process, we manually inputted data about the photograph from information provided by the Tower Bridge, leading to the successful cataloging of an asset, shown in Figure 26.

However, there were some limitations with our findings from the use of the demo system. Because the demo was developed by SSL for demonstration purposes only, there were no customization options for us to try out and we could not use it as a prototype for the actual system Tower Bridge would implement. For example, the demo did not allow for us to add metadata tags for “Archive Subject” to objects, limiting our use of the relational database aspect of the system. Despite this, our use of the demo confirmed that CollectionsIndex+ has sufficient functionality to store, catalog, and find assets in a centralized repository.

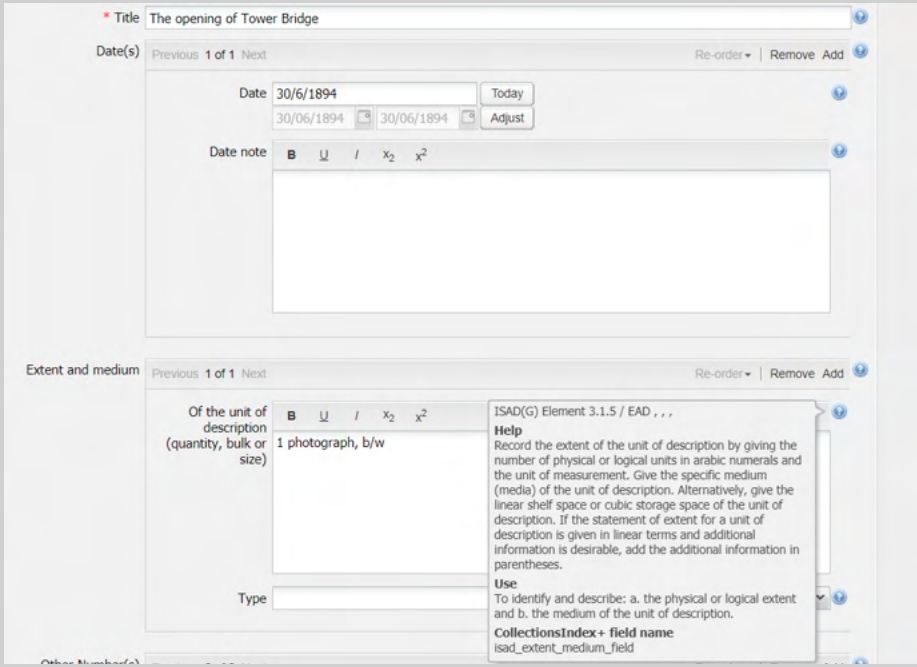


Figure 25: Object entry view with help function in CollectionsIndex+ demo

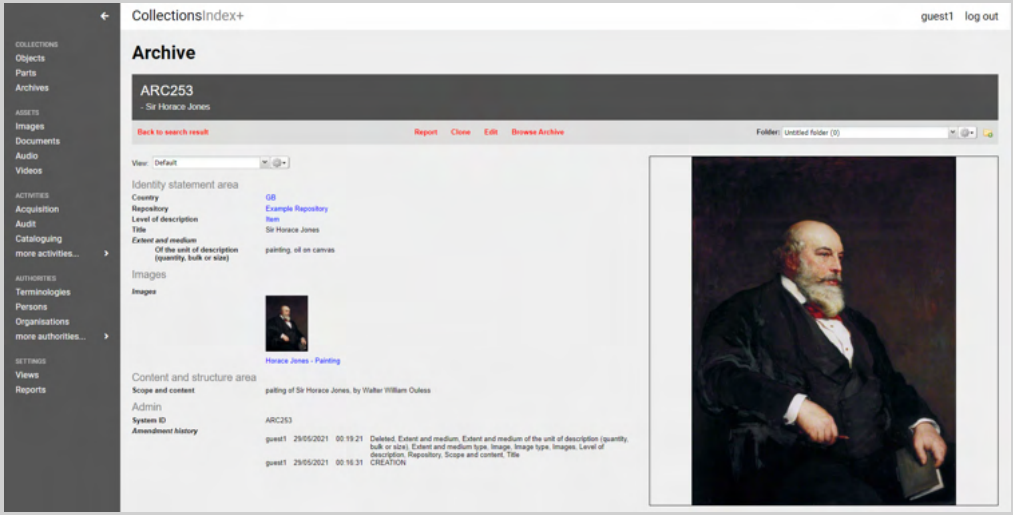


Figure 26: A sample asset from the Tower Bridge collection added to the CollectionsIndex+ demo, used with permission from the Guildhall Art Gallery

Setting-Up and Customizing CollectionsIndex+

After conducting another key informant interview with Richard Beales and Rebecca Arnott from SSL, we learned that the extent of customization may vary, but is available upon Tower Bridge's request (Richard Beales and Rebecca Arnott, personal communication, April 28, 2021). Some of the potential customization options include adding additional data fields or changing the fields shown in the list view of search results. Tower Bridge is interested in the rights and provenance of the assets in their collections, so adding those fields to the default list view shown in Figure 27 can help its staff more easily access that information when searching. Although it is simple for SSL to make changes before the system goes live, Tower Bridge will probably not need too many changes to its repository. However, once the system goes live, there will be a higher cost to make changes due to the increased time needed to perform maintenance on a functional system.

Data Migration

Additionally, we learned about the data migration process into CollectionsIndex+, which can be used if pre-existing cataloging information exists in a unified format at Tower Bridge. SSL representatives stated that having a spreadsheet with consistent asset information can help decide what fields are needed in the system and map the spreadsheet columns to the system fields. Although we received a spreadsheet with sample assets and their information from Dirk Bennett, the majority of the Tower Bridge collection is not documented in the same format. We learned that batch data migration conducted by SSL can simplify the process of populating the CMS with assets, but that in absence of a unified format at Tower Bridge, data entry will most likely need to be manual. Thus, cataloging the assets in the collection will need to be entered manually by Tower Bridge staff or with the help of volunteers.

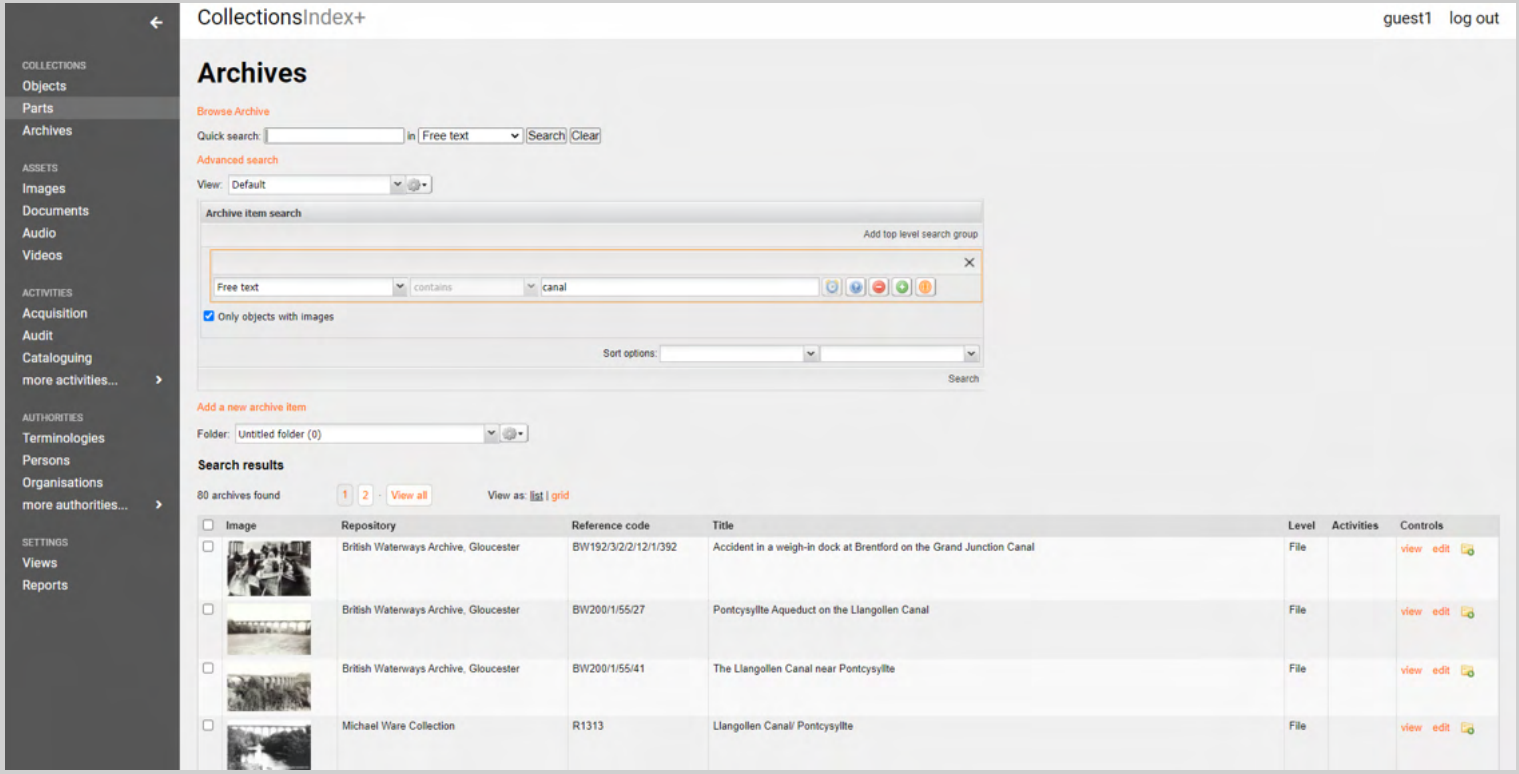
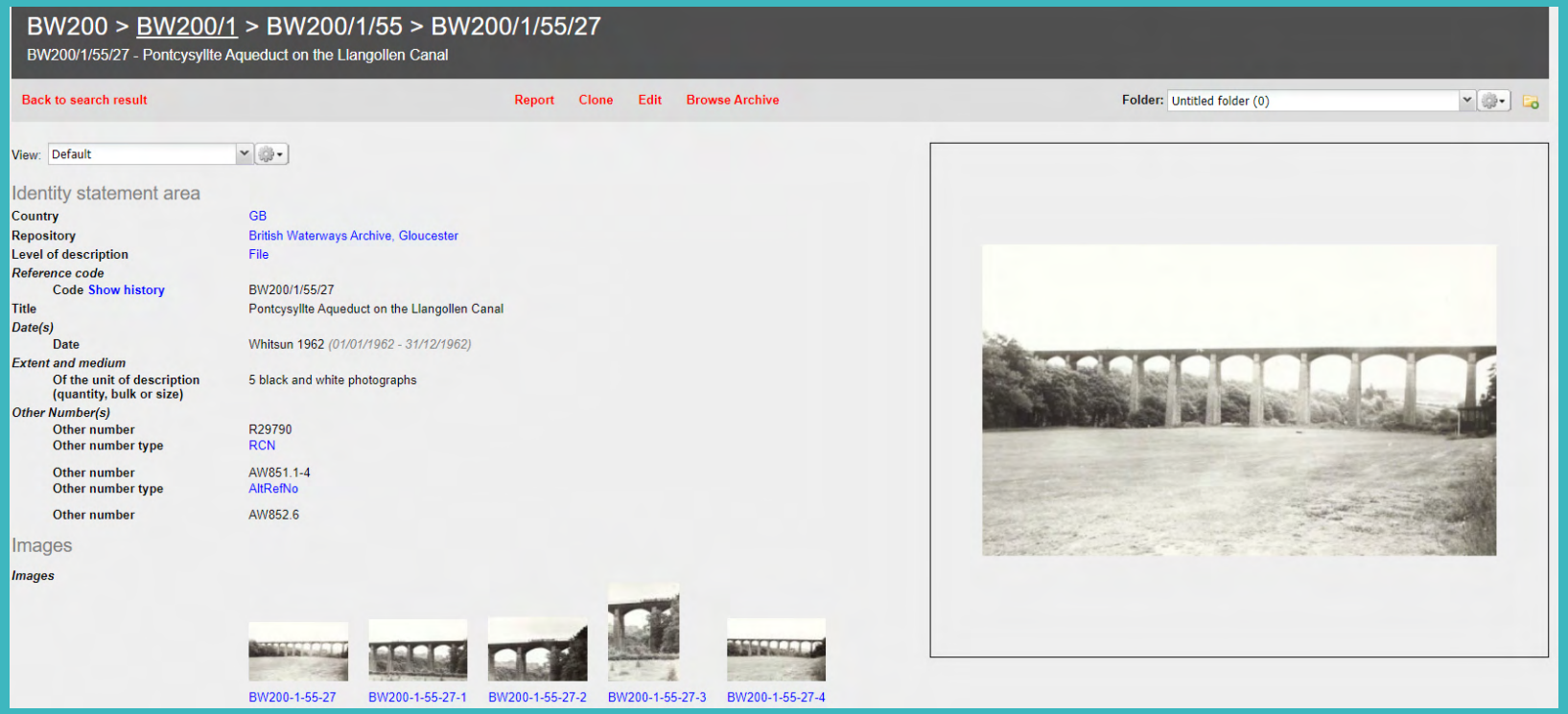


Figure 27: Default list view of the search results for "Canal"



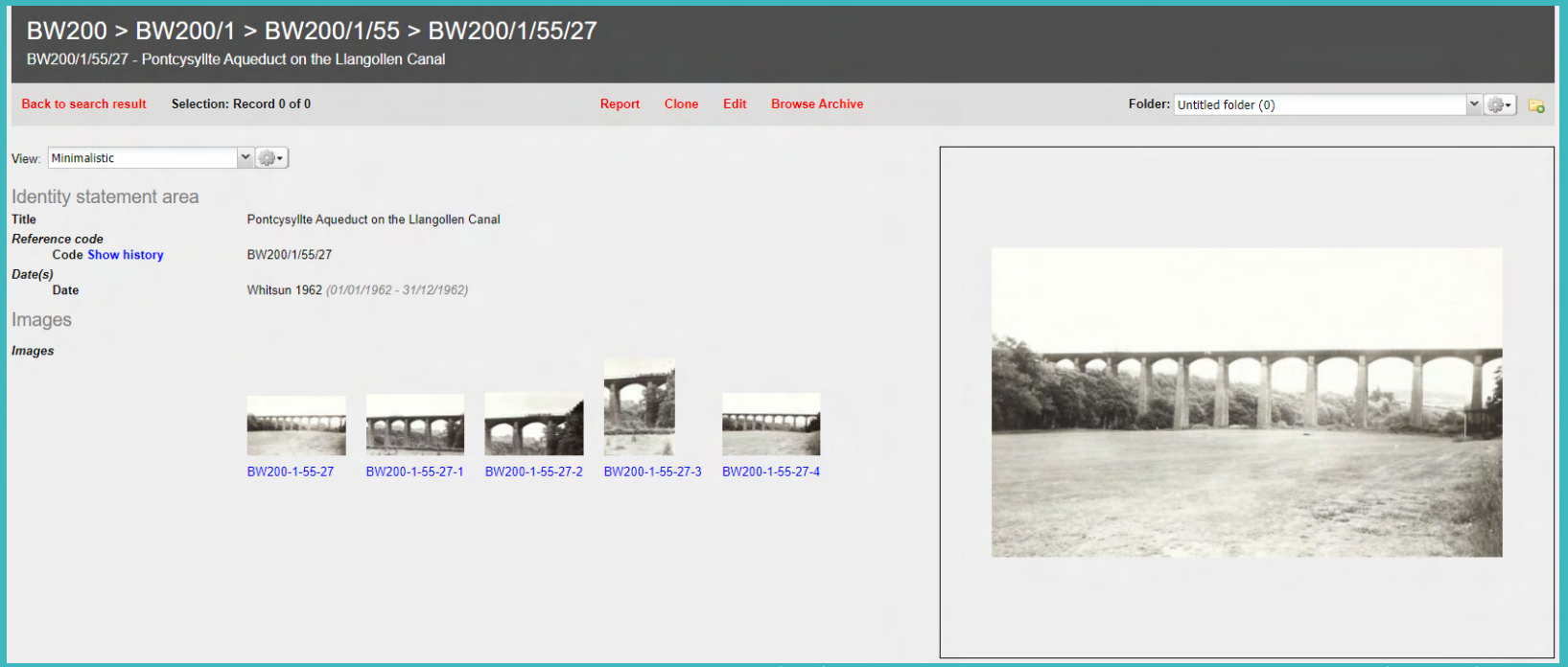


Figure 28: Asset summary for a sample asset in Default view (top) and the same asset summary in Minimalist view (bottom)

Views for Individual Assets Summaries

Another finding from our demo use of CollectionsIndex+ was the ability to create custom views for asset entry and viewing of individual asset summaries. Although there is a default view displaying all information in the asset entry view, different views can be customized to hide certain fields or even categories of fields. This allows for different types of users to streamline the information inputted into the system and removes the clutter of having all fields displayed. As can be seen in Figure 28, views can make it easier to customize and target the information shown for individual assets. Most fields are optional and can be used as needed, although there are required fields for the identification of assets that must be filled in before the asset record can be saved in CollectionsIndex+. The views work for asset entry as well as viewing, allowing for consistency across the system functions.

Recommendations from the Guildhall Art Gallery on Using CollectionsIndex+

In addition to the customization options described by SSL representatives, our questionnaire sent by Dirk Bennett to other institutions in London using CollectionsIndex+ provided more information on the successful customizations done. The key finding from the questionnaire response by Nancy Wade from the Guildhall Art Gallery was that SSL has a thorough understanding of the heritage sector and offers many options to flexibly modify the system. Nancy Wade's response described and displayed the different views for search results, as shown in Figure 29, confirming that customization is possible within the system. The Guildhall Art Gallery implementation of CollectionsIndex+ had different views for asset summaries: Default/Full, Conservation, Curatorial, Survey, and Data Mapping, each with its own set of fields displayed and intended users. From this questionnaire response, we found a successful implementation of how CollectionsIndex+ can have views that anyone can access and use as needed and that users can also set up their custom views for their purposes.

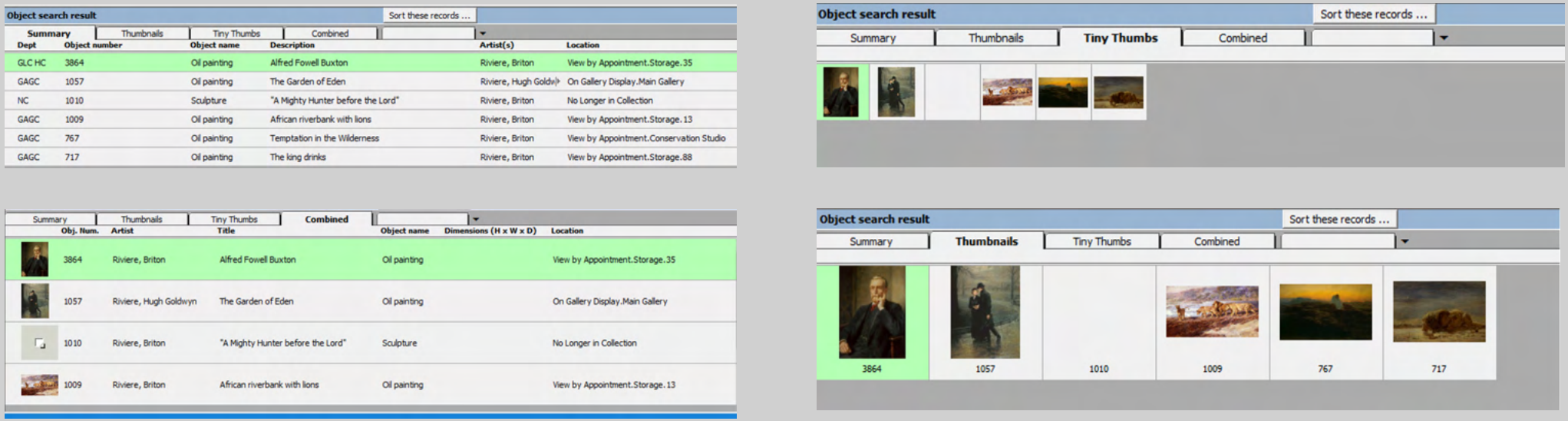


Figure 29: Different views for search results in the Guildhall Art Gallery's implementation of CollectionsIndex+

CONCLUDING REMARKS

The research and findings of this project highlighted important information to consider when looking to implement a collections management system. First, the team discovered that trustworthy organizations such as CHIN and Collections Trust were good sources for identifying potential CMS. For institutions in the UK, it is important to consider only systems that are Spectrum compliant, as that is a necessity for gaining museum accreditation. This allowed us to eliminate several options. Our final list of potential options were Proficio Elements, CollectiveAccess, Axiell Collections, TMS Cataloguer, and CollectionsIndex+. To evaluate these systems, the team used the following 6 criteria: layout & ease of use, scalability & future uses, scope & fitness, maintenance & support, searching, and user groups & permissions. Live demonstrations from system representatives were critical for the evaluation of a CMS. These live demonstrations provided us with key insights into the layout and ease of use, search functionality, and scope/complexity of the system. Both the WPI team and Tower Bridge Staff evaluated the system based on a weighted value analysis. The following are the rankings from the weighted value analyses from most to least suitable:

WPI Team's Rankings

1. CollectionsIndex+
2. Axiell Collections
3. TMS Cataloguer
4. CollectiveAccess
5. Proficio Elements

Tower Bridge Staff Rankings

1. CollectionsIndex+
2. Axiell Collections
3. TMS Cataloguer
4. Proficio Elements
5. Collective Access

Based on these findings, Tower Bridge decided to investigate CollectionsIndex+, with the AssettIndex add-on module, and Axiell Collections. After doing a cost comparison, CollectionsIndex+ proved to be cheaper after 3 years if the system were to be hosted on the cloud. The final result was that Tower Bridge would implement CollectionsIndex+ for their CMS.

The progression of this project led to unexpected adjustments in the project scope and timeline due to unforeseen complexities in the process of setting up a CMS for Tower Bridge and delays due to conflicting schedules. First, the project team spent a lot more time than anticipated researching collections management systems. We discovered that online demonstrations were a necessity for getting a proper understanding of the software. It required an additional 2 weeks of research to schedule and conduct these online demonstrations. Additionally, Tower Bridge staff took twice as long as expected to analyze our findings and make a final decision on which CMS to implement, putting the team another week behind. Most importantly, we did not consider the process for getting budgetary approval for purchasing the CMS. Tower Bridge was unable to purchase the CMS in time for the project team to work with the system. Additionally, once purchased, it would take close to a month to set the system up. These delays in the project resulted in downscaling the project scope from developing the CMS and performing iterative tests, to focusing more on CMS selection and planning out implementation.

A major limitation in our project was the lack of time allocated to capture Tower Bridge's interpretation of the potential CMS we identified. We were given only one hour to present the 5 options we identified to the staff, therefore we had to significantly condense our research into what we interpreted as the most important. By deciding what we would and wouldn't include in the presentation, we were introducing our own biases on what was important in a CMS. Additionally, we had to condense 40 criteria into 6, which could be used to quickly survey the staff's evaluation of a CMS during the presentation. By condensing these criteria, we lost resolution in the staff's interpretation. Also, not everyone surveyed was familiar with cataloging and archiving, as some members were from the marketing and IT departments. All these factors could have affected the data that went into our weighted value analysis, skewing our evaluation of the Tower Bridge staff's interpretation of the potential CMS options.

Recommendations for Tower Bridge

Choosing CollectionsIndex+ for Tower Bridge has set the groundwork for what will be an ongoing project. Future recommendations for utilizing CollectionsIdex+ include:

- Customizing CollectionsIndex+ (see Appendix K)
- Achieving Museum Accreditation (see Appendix L)
- Implementing a Public Website (see Appendix K)

For implementing the system, we have examined customization options for the system that can be employed to tailor it more towards Tower Bridge's needs. Major behavioral changes would not be wise for Tower Bridge as it would be unnecessary and out of their price range, however, minor modifications to data fields and descriptions would be practical. These customizations can be made at any time, allowing the system to grow and adapt to Tower Bridge's needs as they become apparent. Once Tower Bridge staff is comfortable using CollectionsIndex+, we suggest they follow the Collections Trust Manual on the 9 primary procedures to prove Spectrum compliance of their CMS to allow them to gain their museum accreditation. Finally, once the database is fully integrated at Tower Bridge, we recommend implementing a public-facing side to the database. Our background research has shown that online websites are a great way to boost public engagement, and even Nancy Wades' response to the questionnaire on implementing CollectionsIndex+ found that the CMS will be "a valuable asset ... with the future of heritage collections being focused on the sharing and publishing of collections" (Nancy Wade, questionnaire response, April 29, 2021).

Final Reflections

Reflecting on the project, we noted the importance of in-depth background research, avoiding biases in our findings, considering multiple viewpoints, and the long-term effect this project will have on Tower Bridge. When identifying systems, the options were too overwhelming for a basic google search. Researching standards and reputable organizations, such as CHIN and Collections Trust, and the different styles of CMS gave us the background information we needed to sort through the potential options and identify ones that would be suitable for Tower Bridge. When evaluating these systems, we realized that each CMS vendor website was designed to sell the system and thus would never say anything bad about the system. To remove this bias, the team found the use of online demonstrations and hands-on use of the software was the best way to remove the vendors' evaluation of the systems from our findings. Additionally, when we interpreted our findings, we made sure to consider multiple viewpoints at Tower Bridge by keeping all the departments included in our evaluation. This allowed us to get an in-depth understanding of our project by providing insight into the marketing, exhibit, and IT requirements for the CMS. Tower Bridge plans to move forward with CollectionsIndex+ to build its centralized repository. This system will lay the foundation for significant amounts of digital engagement both in person at the museum or online, allowing Tower Bridge to manage its assets internally and share its collection across the globe.

BIBLIOGRAPHY

1. Alexander, E. P., Alexander, M., & Decker, J. (2017). *Museums in Motion: An Introduction to the History and Functions of Museums*. Rowman & Littlefield.
2. Ameli, N. (2008). *Proprietary and open source collections management systems: Two case studies | Digital Repository* [Ryerson Univeristy]. https://digital.library.ryerson.ca/islandora/object/RULA%3A4160
3. Arinze, E. N. (1999). *The Role of the Museum in Society*. 4.
4. Baca, M., Erin, C., & Sally, H. (2008). Metadata and Museum Information. In P. F. Marty & K. B. Jones (Eds.), *Museum Informatics: People, Information, and Technology in Museums*.
5. Barts Archives. (2017, December 12). What is cataloguing, and why do we do it? *A STUDY IN SPECIALISM: Cataloguing and Conserving the Archives of St Mark's Hospital*. https://astudyinspecialism.wordpress.com/2017/12/12/what-is-cataloguing-and-why-do-we-do-it/
6. Bowditch, J. (2015). The Smithsonian as a Microcosm of American Museum Practice. *Technology and Culture*, *56*(1), 248–251.
7. Bowen, J. (2000). The virtual museum. *Museum International*, *52*(1), 4–7. https://doi.org/10.1111/1468-0033.00236
8. Brown, K., & Mairesse, F. (2018). The definition of the museum through its social role. *Curator: The Museum Journal*, *61*(4), 525–539. https://doi.org/10.1111/cura.12276
9. Brownell, G. (2020, June 18). Extending a Lifeline to Museums. *The New York Times*. https://www.nytimes.com/2020/06/18/arts/masterpiece-london-museums.html
10. Burton, C., & Scott, C. (2003). Museums: Challenges for the 21st Century. *International Journal of Arts Management*, *5*(2), 56–68.
11. Canadian Heritage Information Network. (2017a, August 28). *Collections Management in Canadian Museums: 2016 Results*. Canada.Ca. https://www.canada.ca/en/heritage-information-network/services/collections-management-systems/collections-management-museums-survey-results-2016.html
12. Canadian Heritage Information Network. (2017b, August 28). *Collections management system criteria checklist*. Canada.Ca. https://www.canada.ca/en/heritage-information-network/services/collections-management-systems/software-criteria-checklist.html
13. Chin, S.-H., Chen, C., Ko, P.-C., & Lin, S.-Y. (2019). Design of museum advertisement picture management system based on web. *Journal of Visual Communication and Image Representation*, *63*, 102595. https://doi.org/10.1016/j.jvcir.2019.102595
14. Ciolfi, L., & McLoughlin, M. (2012). Designing for meaningful visitor engagement at a living history museum. *Proceedings of the 7th Nordic Conference on Human-Computer Interaction Making Sense Through Design - NordiCHI '12*, *69*. https://doi.org/10.1145/2399016.2399028
15. *Cloud vs Local Servers: Weighing up the Pros and Cons*. (2019, June 27). Evolvit. https://evolvit.co.uk/it-support/server-support/cloud-vs-local-servers-weighing-up-the-pros-and-cons/
16. Cunningham, D. G., Bowe, R. C., & Vagnini, T. P. (2019). *Evaluation of Visitor Experience at the Tower Bridge Exhibition*. 109.
17. *DCMS-sponsored museum visit trends*. (2020). Morris Hargreaves McIntyre. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920055/DCMS_Sponsored_Museum_Visit_Trends_Main_Report.pdf
18. Enrico, B., & Federico, M. (2011). *The Future of Museums in the Digital Age: New Models of Access and Use of Digital Collections*. University of Turin.

19. Friedman, H. H., & Amoo, T. (1999). Rating the Rating Scales. *Journal of Marketing Management*, *Winter*, 114–123.
20. Graburn, N. (1977). The Museum and the Visitor Experience. *Roundtable Reports*, 1–5.
21. Griffiths, A. (2010). Collections Online: The Experience of the British Museum. *Master Drawings*, *48*(3), 356–367.
22. Grohe, M. (2020). For the Education and Enjoyment of the Public Forever. *Journal of Museum Education*, *45*(2), 115–126. https://doi.org/10.1080/10598650.2020.1755796
23. Hibbert, M. (2014). *What Makes an Online Instructional Video Compelling?* https://er.educause.edu/articles/2014/4/what-makes-an-online-instructional-video-compelling
24. Hooper-Greenhill, E. (1999). *The educational role of the museum*. Psychology Press.
25. Hudson, K. (1975). *A Social History of Museums: What the Visitors Thought*. Springer.
26. *Introduction to Spectrum 5.0 – Collections Trust*. (n.d.). Collections Trust. Retrieved February 15, 2021, from https://collectionstrust.org.uk/spectrum/procedures/
27. Jacobsen, J., Schlenker, T., & Edwards, L. (2005). *Implementing a Digital Asset Management System: For Animation, Computer Games, and Web Development*.
28. Jeng, L. H. (2002). What Authority? Why Control? *Cataloging & Classification Quarterly*, *34*(4), 91–97. https://doi.org/10.1300/J104v34n04_09
29. Kegan, M., Kegan, C., & Kegan, T. (2017). *Organizational Culture and Change: Making the Case for Inclusion.* 34–75.
30. Kelly, F. (2019). 'Man sorting books': Historical research in an archive of university photographs. *History of Education*, *48*(1), 99–117. https://doi.org/10.1080/0046760X.2018.1506050
31. Kelly, L. (2004). Evaluation, Research and Communities of Practice: Program Evaluation in Museums. *Archival Science*, *4*(1), 45–69. https://doi.org/10.1007/s10502-005-6990-x
32. Lewis, G. (2011). The history of museums. *Encyclopaedia Britannica*, *24*.
33. MacDonald, G. F., & Alsford, S. (2010). The museum as information utility. In *Museums in a Digital Age* (pp. 72–79). Abingdon, Routledge.
34. Marty, P. F. (2008). Museum websites and museum visitors: Digital museum resources and their use. *Museum Management and Curatorship*, *23*(1), 81–99. https://doi.org/10.1080/09647770701865410
35. Matassa, F. (2011). *Museum Collections Management*. Facet Publishing.
36. Ménard, E., Mas, S., & Alberts, I. (2010). Faceted classification for museum artefacts: A methodology to support web site development of large cultural organizations. *Aslib Proceedings*, *62*(4/5), 523–532. https://doi.org/10.1108/00012531011074753
37. Mihelj, S., Leguina, A., & Downey, J. (2019). Culture is digital: Cultural participation, diversity and the digital divide. *New Media & Society*, *21*(7), 1465–1485. https://doi.org/10.1177/1461444818822816
38. *Museums 2020 Discussion Paper*. (2012). Museums Association. https://www.museumsassociation.org/app/uploads/2020/06/24072012-discussion-paper.pdf
39. *On-Premise vs. Cloud Pros and Cons | Which is Better?* (2019, December 27). Morefield Communications. https://www.morefield.com/blog/on-premises-vs-cloud/
40. Parry, R. (2013). *Museums in a digital age*. Routledge.
41. Pine, B. J., & Gilmore, J. H. (2001). Welcome to the experience economy. *Health Forum Journal*, *44*(5), 10–16.
42. Povroznik, N. (2018). *Virtual Museums and Cultural Heritage: Challenges and Solutions*. 8.

43. Samaroudi, M., Echavarria, K. R., & Perry, L. (2020). Heritage in lockdown: Digital provision of memory institutions in the UK and US of America during the COVID-19 pandemic. *Museum Management and Curatorship*, *35*(4), 337–361. https://doi.org/10.1080/09647775.2020.1810483
44. Simmons, J. E. (2016). *Museums: A History*. Rowman & Littlefield.
45. Simon, N. (2010). *The participatory museum*. Museum 2.0.
46. *Spectrum around the world – Collections Trust*. (n.d.). Retrieved April 12, 2021, from https://collectionstrust.org.uk/spectrum/spectrum-around-the-world/
47. Srinivasan, R., Boast, R., Furner, J., & Becvar, K. M. (2009). Digital Museums and Diverse Cultural Knowledges: Moving Past the Traditional Catalog. *The Information Society*, *25*(4), 265–278. https://doi.org/10.1080/01972240903028714
48. Sully, P. (2006). *Inventory, access, interpretation: The evolution of museum collection management software*.
49. Swank, A. M. P. (2008). *Collection Management Systems*. 206.
50. The British Museum. (2019). *British Museum collection Fact Sheet*. https://www.britishmuseum.org/sites/default/files/2019-10/fact_sheet_bm_collection.pdf
51. The National Archives. (2018, February 21). *The National Archives—Cataloguing archive collections—The National Archives* [Text]. Archives Sector; The National Archives. http://www.nationalarchives.gov.uk/archives-sector/advice-and-guidance/managing-your-collection/developing-collections/cataloguing-archive-collections/
52. The pros and cons of cloud vs in house servers. (2019, October 5). *SysGen*. https://sysgen.ca/cloud-vs-in-house-servers/
53. *Tower Bridge | Description, History, & Facts | Britannica*. (n.d.). Retrieved February 15, 2021, from https://www.britannica.com/topic/Tower-Bridge
54. *Tower Bridge: History*. (n.d.). Tower Bridge. Retrieved February 15, 2021, from https://www.towerbridge.org.uk/discover/history
55. *Tower Bridge Interpretation Plan*. (2015).
56. Vaizey, E. (2016). *The Culture White Paper*. The Department of Digital, Culture, Media, and Sports.
57. VisitEngland. (2019). *Most visited paid attractions in London 2019*. Statista. https://www.statista.com/statistics/425236/most-visited-paid-attractions-in-london/
58. Weibel, S. (1995, July). Metadata: The Foundations of Resource Description. *D-Lib Magazine*. http://www.dlib.org/dlib/July95/07weibel.html
59. Weibel, S. (2005). The Dublin Core: A Simple Content Description Model for Electronic Resources. *Bulletin of the American Society for Information Science and Technology*, *24*(1). https://asistdl.onlinelibrary.wiley.com/doi/full/10.1002/bult.70
60. *What is a relational database?* (n.d.). Retrieved April 12, 2021, from https://www.oracle.com/database/what-is-a-relational-database/
61. *What is open source?* (n.d.). Opensource.Com. Retrieved March 13, 2021, from https://opensource.com/resources/what-open-source
62. Williams, D. (2010). A brief history of museum computerization. In *Museums in a digital age* (pp. 15–20). Routledge London, New York.

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