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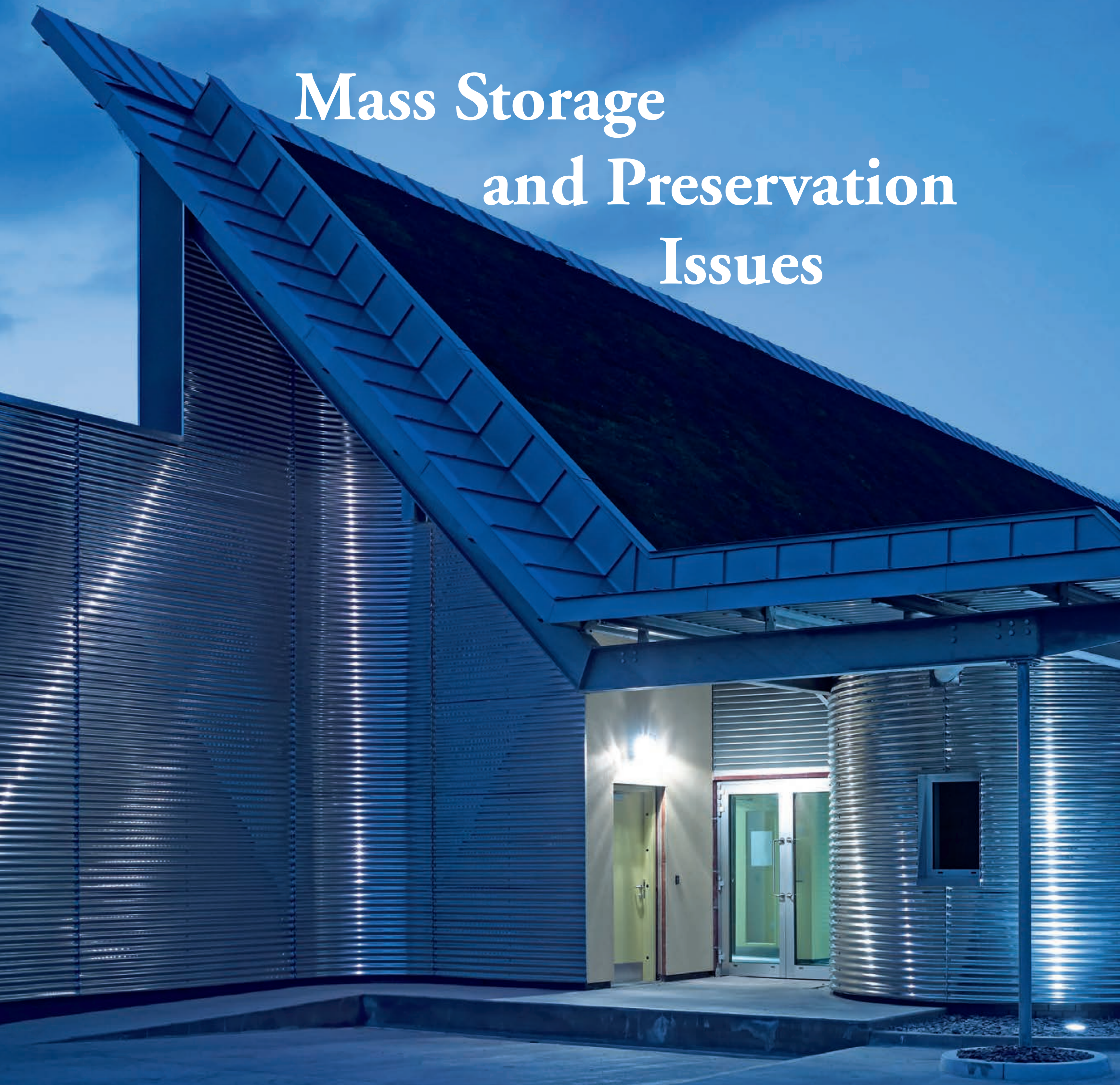

Mass Storage and Preservation Issues

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IFLA-PAC
Bibliothèque nationale de France
Quai François-Mauriac
75706 Paris cedex 13
France

Director:
Christiane Baryla
Tel: ++ 33 (0) 1 53 79 59 70
Fax: ++ 33 (0) 1 53 79 59 80
E-mail: christiane.baryla@bnf.fr
Editor / Translator
Flore Izart
Tel: ++ 33 (0) 1 53 79 59 71
E-mail: flore.izart@bnf.fr
Spanish Translator: Solange Hernandez
Layout and printing: STIPA, Montreuil

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Front cover:
British Film Institute Master Film Store.
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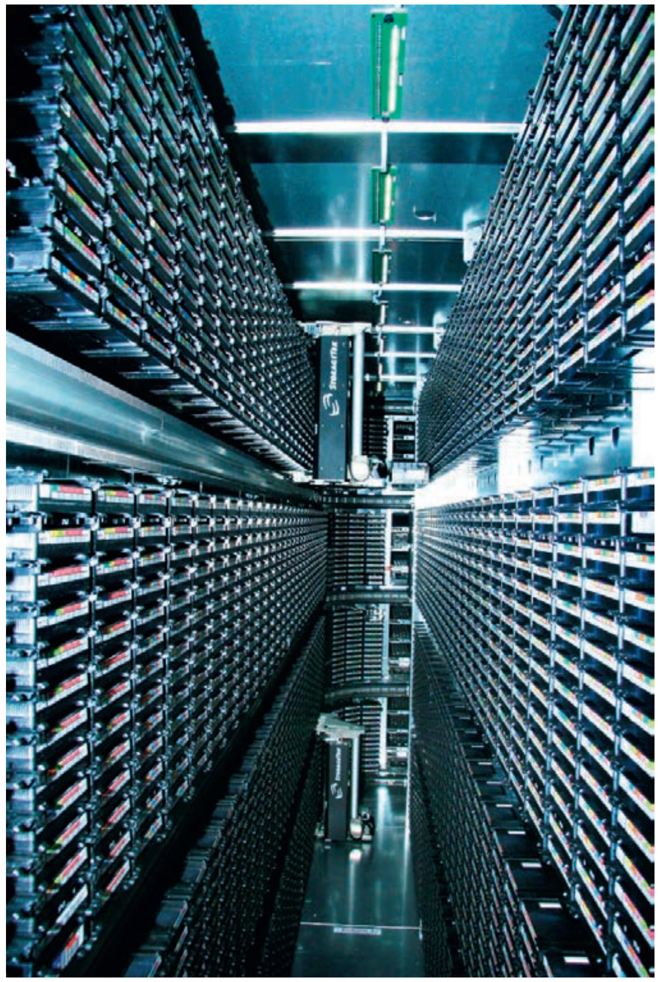
Mass Storage and Preservation Issues

The recent IFLA World Library and Information Congress in Helsinki gave to the PAC Core Activity the opportunity to propose a session entitled "Storage and repositories: new preservation and access strategies". We had a good attendance at our meeting, which showed the particular importance of this topic for our colleagues, regardless of their home institution: library, archives, museums (http://conference.ifla.org/ifla78/programme-and-proceedings-day/2012-08-13). That is why we decided to explore this topic a little deeper in this n° 57 of *International Preservation News*.



Scalable Preservation and Archiving Repository (SPAR) © Patrick Bramoulé / BnF

Libraries and other institutions in charge of archiving cultural heritage are experiencing a pivotal time: a time of transition between traditional paper collections and new virtual ones, a time of transition between different types of storages and repositories, a time of transition between different methodologies in the storage spaces management.

This time of transition also means that the transfer from analogue collections to digital ones does not imply a simple substitution of paper by the digital form. The challenge is that for some time librarians will have to deal with paper and digital collections together, traditional storages and virtual repositories.

In the field of conservation, far from being simplified, the librarian tasks are heavier and more challenging.

The selection of articles which follow tries to explore these topics through the cases of the British Library and the Bibliothèque nationale de France. The storage of audiovisual and films collections is presented too through the new building of the British Film Institute and the Church of Jesus Christ of Latter-day Saints repositories in Salt Lake City. While a new methodology in museum storage is proposed by Simon Lambert from CCI in Ottawa, the British Library is implementing storage solutions which can be of high interest for smaller collections with limited budgets and resources.

We suggest a cross-reading together with the proceedings of IFLA 2012. You could have a more accurate and diversified picture of the current changes in the preservation and storage field. Our next IPN scheduled for December 2012 will be dedicated to the digitization of old maps. We wish you all a good reading.

Christiane Baryla
IFLA-PAC Director

The Changing Face of Storage at the British Library

by Deborah Novotny, Head of Collection Care, British Library, UK

Abstract

This paper discusses how the British Library is changing the way it stores its collections whilst at the same time ensuring that they are housed in optimal environmental conditions. It gives an overview of current library buildings, including the two new high-density storage facilities at Boston Spa, with particular emphasis on newspaper storage. It examines the changing standards in relation to BS 5454 and PAS 198 and the affect of this on the library storage environment in the UK.

Introduction

The British Library is one of the largest institutions of its kind in the world. With its flagship building in London, St Pancras, a large document supply centre in the North of England (Boston Spa), and a dedicated newspaper library in North London (Colindale), it comprises over 150 million items. The collections require an estimated 625 kilometres of shelving and continue to grow.
There have been significant changes with regards to the library's estates strategy with the emphasis on moving to a two-site operation (London St Pancras and Boston Spa).
Not surprisingly, all space – for storage, readers, public and staff – remains at a premium and high on the British Library's list of strategic priorities. It was the demand for space that saw the British Library move from its historical location within the British Museum into a new, purpose-built home at St. Pancras in central London in 1997.

With a total floor area of 112,000 sq metres spread over fourteen floors (nine above ground and five below) this building was the largest public building constructed in the UK in the 20th century. The majority of the library's collections are stored below ground, in the climate-controlled basement areas (17°C – 50% RH), where there is also specialist shelving to facilitate the safe storage and retrieval of large items.

1. The British Library, St Pancras, London.

St. Pancras

The design and construction of the St Pancras building took over twenty years at a cost of £500m.
Because St Pancras was a new build, there was plenty of control over building specifications, such as the construction and fire resistance of the internal and external fabric of the building.

For example:
- The building is protected by an analogue addressable fire alarm and detection system, believed to be the largest system currently in use in the UK.
- There are 3,000 combined obscuration/ionisation and heat detectors plus beam, smoke and flame detectors.
- The Fire Alarm and Detection System (FADS) is interfaced with the Building Energy Management System (BEMS) which, in the event of fire, shuts down the air-conditioning system in affected areas to prevent the spread of smoke.
- There is a wet sprinkler installation - which replaced the original dry system - plus Inergen in the basements, the strongrooms, transformer rooms and electrical substations.

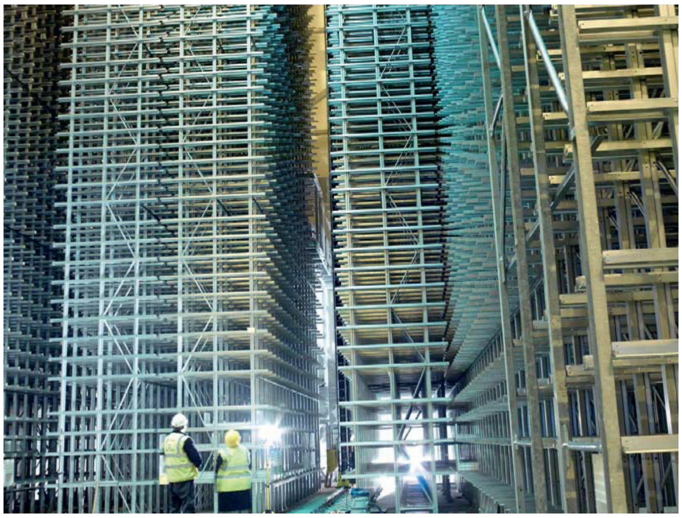
The issue of storage is ongoing and consequently figures prominently in the library's strategies, with specific priorities focussing solely on the storage of the collections and the integration of storage models with long-term preservation. For example, these include :

- Complete the new storage building at Boston Spa;
- Update British Library property strategy – fundamentally moving to a two-site operation and addressing growth and storage needs over the next 25 years.

Boston Spa – Storage of Monographs & Low Use Material (Building 31)

In moving this priority forward, the Library successfully secured funding from Government for a new storage facility at Boston Spa and planning permission for a single building to store monographs (primarily) and low use material on this site was subsequently granted in February 2006. The aim was to deliver a building that would last for seventy years, be sustainable in terms of running and life cycle costs and meet UK directives on green issues, in addition to delivering additional safe storage at best value for money.
The building for monographs/low use material (known as ASP [Additional Storage Programme] Building 31) is an innovative design with an automated storage and retrieval system and ground-breaking fire prevention and will provide housing for approximately seven million collection items when full.

2.A. Building 31, The British Library,



2.B. High density, Building 31. Boston Spa, Yorkshire.

During the planning stage for this build, a range of storage options was considered, including established conventional systems with combinations of low and high racking, fixed and mobile racking. However, none of these solutions was able to provide the quantity and quality of storage for the funds that were available and high-density storage was the next option to be explored. High density storage is becoming increasingly commonplace in research libraries worldwide, and is not new technology, but the British Library wanted to marry the high density solution with a fully automated system; a combination used frequently in warehouse management but rarely in libraries and archives on the scale the British Library was proposing.

The system relies on automated software for all aspects of the operation. Staff do not work in the storage voids, each of which has four high level temperature and humidity sensors, but in 'picking stations', which are physically separate from the storage voids. This construction allows the vast storage space to remain dark and stable with emergency lighting only.

The system installed in Building 31 directs automated cranes up and down the storage aisles to 'pick' specific storage containers (known as 'totes') from their allocated storage space and deliver them to a conveyor belt, which transports them out of the storage void to the manned picking stations. Here, staff can retrieve the requested items in a normal working environment. The process is reversed to return items to storage.

With such a dramatic shift away in storage solutions from more traditional library systems, the impact on, and risks to collections were thoroughly explored and debated.

A decision was made early on in the design stage of this project to use an aspirated fire detection system (Very Early Smoke Detection Apparatus - VESDA), which is most commonly used in high density stores. However, with such a departure from conventional storage, there was an opportunity to investigate and test a wide variety of fire prevention and suppression systems, including sprinklers and high-pressure misting and, for fire prevention, low-oxygen. Extensive analysis of these options combined with a comprehensive risk assessment led the library to adopt a low-oxygen (OxyReduct) system for fire prevention in the new building.

The low oxygen environment system operates at 15% oxygen and works by reducing the oxygen content of the atmosphere by adding nitrogen. At this oxygen level it is possible to breathe normally but flammable substances will not burn and a fire cannot start. The usual mixture of gases that we breathe contains 21%-22% oxygen, with most substances needing at least 16.5% oxygen to ignite and burn.

A test carried out by the library in a controlled simulated environment demonstrated that it was impossible to ignite and burn paper using an Oxyacetylene torch. In the test cell the ratio of oxygen to nitrogen was reduced from 20:80 under normal conditions, to15:85, close to what it would be in the new storage building.

The biggest challenge in using a low-oxygen environment system is to ensure that the building is air-tight. If it is not, then the conditions which are essential to avoid potential fire hazards are compromised and the collections are at risk.

Boston Spa – Storage of Newspapers (NSB)

Another of the Library's strategic priorities also focuses on storage, but in a more specific context, that being the preservation of and access to the library's newspaper collections. The driver behind this priority was a Preservation Needs Assessment Survey (PAS) carried out in 2001, which showed the newspaper collection to be the most vulnerable of all of the BL's collections, with just over 30% being in poor/unusable condition.

3. The new newspaper storage building takes shape at Boston Spa.

Again, a new build underpins this priority - the construction of a purpose-built facility at Boston Spa specifically for newspapers. In November 2009 the UK government confirmed a commitment of £33m to fund the British Library's Newspaper Strategy. This assurance enabled the library to plan for the long-term preservation of the newspaper collection by constructing a dedicated newspaper storage facility at Boston Spa. The newspaper library at Colindale will close in 2013, after which access to the newspaper collection will largely be via surrogates (both microfilm and digital) in a dedicated reading room at St Pancras.

The new newspaper storage building (NSB) will accommodate some 128 kilometres of newspapers (approximately 287,000 items) again in a low-oxygen environment. The proposed building has a footprint of 3924m^2 and is a high-density, automated system operating with a temperature of 13°C and 40% relative humidity.

The benefit of this new storage environment can be measured by the improved change in the newspapers' Preservation Index (PI). PI is a concept introduced by the Image Permanence Institute in 1995 to express the "preservation quality" of a storage environment for organic materials. PI has units of years. The higher the PI, the better conditions are for preservation of organic materials.

The new building's environment will result in an increase in PI from 50 to 140 years before deterioration is first noted.

Retrieval of the newspapers will be via an automated, computerised picking system, with the capacity to retrieve at 45 complete cycles per hour (both in and out). Unlike the monographs stored in Building 31, however, the newspaper items will not be in totes. In NSB the collection will be grouped into stacks of items according to agreed criteria. Each item is individually bar-coded, and stacked in groups between two specially designed boards, which are secured with a strap mechanism. Various combinations of stacks are then allocated to a single carrier tray, and it is the carrier tray that is retrieved to deliver the requested content.

The Library is preparing well for the move and the transformation of its services, a key element of which is access by digital and microfilm surrogates. Poor and unusable items are being shrink-wrapped for the move and 124,000 items have already been bar-coded out of a total of 287,000. NSB is scheduled to start ingesting collection material from Colindale in November 2013 with completion (of Colindale material) in July 2014.

Microfilm Collection & Acetate

While these high-profile builds are helping to preserve the Library's hard copy collections, we are mindful that the significant number of (analogue) surrogate assets that the library has amassed over the years have a role to play in enabling access to their content. Consequently, the preservation of these assets has been actively managed as part of the Library's general approach to the care of its collections.

One of the major risks to the library's microfilm holdings is posed by acetate film. Much has been documented about acetate degradation and the general consensus that this can be inhibited by storing acetate in cool, dry conditions. Because of the sheer quantity of acetate film in the Library's collections (much of which is related to the newspapers and some of which has no hard copy equivalent), we decided to adopt cool storage as the long term strategy for its master negative microfilm collection. In February 2009 after three years of research and consultation, the British Library awarded, through the EU tendering process, an external contract for the off-site provision of microfilm storage at 5°C and 35% RH.

Under the contract, a suite of 10 cold rooms has been built, in a space dedicated to the British Library, each with its own independent monitoring system. This gives huge flexibility for the storage of the collection should certain parts of it need to be in changed conditions in the future. The shelving in each room is perforated to allow maximum exposure to the conditioned air. Also constructed as part of the suite was an acclimatisation room, so that film coming in or out of the cold rooms is brought to the relevant temperature slowly and safely.

Moving the film to a much improved environment has resulted in the following benefits:

- For degrading acetate film (about one third of the collection), we have increased the time in which free acidity will double from about 10 years to approximately 200 years and for polyester film we have increased the Preservation Index from 63 years to 488 years[1].

1. These figures are estimates based on the pre-existing storage conditions and derived by utilising as far as possible the ranges of figures given in the IPI Storage Guide for Acetate Film and the IPI Media Storage Quick Reference

4.A. Cold Storage Suite for BL microfilm masters.

4.B. Films are re-canned and bar-coded.

- There have been other collections management benefits of this move. With every can/reel in the collection having to be handled to be bar-coded, some for the first time in many years, we have been able to do some much-needed housekeeping.

Currently we have over 28,000 x 1000 ft cans and more than 120,000 x 100 ft reels of master microfilm of newspapers stored in this new facility.

Changing Standards: British Standard BS 5454 and PAS 198

Most of us in the heritage sector in the UK are familiar with and have historically worked to BS5454 when assessing and/or creating non specialised storage environments for archive materials. This BSI (British Standards Institute) standard has provided an accepted benchmark for storage across the sector. First issued over 30 years ago, it is however, struggling to remain as flexible and evidence-based as today's agendas, economies and heritage strategies demand.

British Standard 5454 "Recommendations for the storage and exhibition of archival documents" was first issued in 1977. It was revised in 1989 and 2000.
It contains a lot of useful information about the siting, design and construction of library and archive buildings, storage and display furniture and appropriate materials for housing and packaging books and archives. It also contains a brief section (section 7.3) specifying the acceptable ranges for temperature and relative humidity for libraries and archives. For frequently handled paper documents, the temperature should be between 16° and 19° with a tolerance of 1° on either side, while the relative humidity should be between 45% and 60% with a tolerance of 5% on either side.

To place these figures in context, we should bear in mind what Gary Thomson said in his influential book *The Museum Environment*, first published in 1978:

"Choice of RH level depends on several factors but cannot go too far from 50 or 55% RH … The tolerance usually quoted of ± 4 or 5% RH is based more on what can be expected of an air-conditioning plant than on what exhibits can actually stand without deterioration, which is not known in any detail."

We should also bear in mind that the standard was prepared in the aftermath of the first energy crisis of 1973, when the concern was whether fossil fuels would continue to be available in the quantities and at the prices that prevailed beforehand, rather than any concern over the effect that the continued and increasing consumption of fossil fuels might have on the earth's environment.

BS 5454 was a British standard, implicitly written for a British audience. Its recommendations were appropriate for the British climate – temperate maritime (cool and damp).

However, there were no other standards for museums housing other kinds of collections, nor were there recommendations for appropriate storage conditions in other types of climate – e.g. tropical (hot and damp) or continental (cold and dry).

As a consequence, the recommendations for appropriate storage conditions for books and archives in the British climate tended to be adopted for all kinds of collections in all kinds of climates. "BS 5454 conditions" came to be accepted as the shorthand for the general museum environmental standard. In fact, it is appropriate, though rather restrictive, for general organic collections, including easel paintings, furniture and textiles.

Unfortunately it is not appropriate for archaeological metals, some of which have suffered corrosion as a result of being kept at too high a relative humidity. Nor is it appropriate for museums in cold climates, which have suffered structural damage as a result of trying to maintain an internal RH of 55% during the winter, or for museums in tropical climates with unreliable power supplies that have tried to maintain an internal temperature of 20° throughout the year.

There had been a growing awareness since the mid-1990s that tight environmental specifications might not be essential for all classes of museum object, and various people had tried to resolve Garry Thomson's point about the vulnerability of real objects to environmental conditions being unknown, by making direct measurements of their response to environmental fluctuations. Nevertheless, there was still a feeling amongst some conservators that the aim should be for closer and closer control of the environment, for the benefit of the collections.

Ironically, the most influential call for a re-assessment of environmental conditions came not from conservators but from the directors of national museums in the UK. In 2009, the National Museum Directors Conference issued a statement that:

"Museums need to approach long-term collections care in a way that does not require excessive use of energy, whilst recognising their duty of care to collections. There is general agreement that it is time to shift museums' policies for environmental control, loan conditions and the guidance given to architects and engineers from the prescription of close control of ambient conditions throughout buildings and exhibition galleries to a more mutual understanding of the real conservation needs of different categories of object, which have widely different requirements and may have been exposed to very different environmental conditions in the past."

Following a pilot project funded by the Science and Heritage programme of the UK's Arts and Humanities Research Council and the Engineering and Physical Sciences Research Council, a committee was set up under the auspices of the British Standards Institution to produce a guideline for managing the environment for all kinds of collections. This produced PAS 198:2012 "Specification for managing environmental conditions for cultural collections".
At the same time, but independently, the periodic review of BS 5454 had concluded that it would be appropriate to change its format to a guideline rather than a specification, and to recommend that environmental fluctuations should be allowed to occur within specified ranges, rather than insisting on tight control. The document is now called PD 5454:2012 "Guide for the storage and exhibition of archival materials".
PAS 198 is very different from previous documents since it adopts an evidence-based approach and requires each institu-

tion to undertake an assessment of the environmental risks to its collection. Particularly important is the requirement to set a realistic life expectancy for the collection and to manage the environment so as to achieve this, taking into account the resulting energy demand. It is not sufficient to say that the collection will be preserved in perpetuity. Rather, it is necessary to assess the significance of the collection, or each section of the collection, deciding what features of the collection should be preserved, for what reasons.

For example, in a library collection, it may be decided that the significance of one part of the collection can be adequately preserved by means of a surrogate, while for other parts of the collection it is the physical existence of the items that must be preserved.

Clearly, in order to undertake a risk assessment for a collection, it is necessary to know what materials are present, their current condition, and the ways in which the collection is accessed or used. Its vulnerability to temperature, relative humidity, light and pollution can then be assessed.

Finally, on the basis of the known vulnerability of the collection, the aspects of the collection that convey its significance, and its desired useful lifetime, it is possible to set appropriate environmental parameters. These parameters may be different for different parts of the collections, depending on the materials from which they are made, their significance and their vulnerability to different aspects of the environment.

In general, then, one size will not fit all. A library may demand close environmental control for a manuscript collection deemed to be of high cultural significance, while a lending collection of modern books which are not intended to be retained in the long term may be kept under less stringently controlled conditions. Similarly, a museum collection of stable stone statuary can be safely exposed to quite large fluctuations in temperature and relative humidity without harm, while a collection of archaeological ironwork, even if of comparatively low significance, will nevertheless require to be kept at low relative humidity if it is to survive at all.

The British Library had already started to look critically at its energy consumption, and particularly the energy consumption of its storage areas, before PAS 198 and BS 5454 were published. We carried out an energy survey and have reduced our energy consumption by 30% over 3 years, largely by replacing inefficient boilers and replacing fluorescent light with LEDs. We have established that we can switch off the air conditioning overnight and at weekends in the basement storage areas in our main building in central London, without the relative humidity drifting more than 5% from the set point. We also know that this amount of fluctuation has an imperceptible effect on tightly-packed shelves of books.

Much of our little-used collection is kept in our high-density automated store at Boston Spa. This store is maintained at 14° ± 1° and 50% ± 5% RH. This represents the limit of what was permitted under BS 5454 at the time the building was designed. We are currently in the process of constructing a second high-density store to house the national newspaper collection. The intention is that once the whole collection has been digitised, there will be no further need to access the physical newspapers. This building will be kept at a nominal 13° and 40% RH, but the temperature will be allowed to drift upwards by no more than 3° for 24 hours in summer or as a result of heat emitted by the machinery. The building will not be heated, even in winter, because there will be no staff in the storage area. Similarly, the relative humidity will be allowed to rise by no more than 5% for 24 hours.

As a first step towards implementing PAS 198, we intend to establish how much material we have in our collections that is not paper or parchment-based. Given the size of the collections, this may take some time to complete. We have already re-housed some vulnerable metal items under low relative humidity to inhibit corrosion, and we have a dedicated cold store for cellulose acetate microfilm. However, the design of our main building at St Pancras is such that it will be quite difficult to construct storage areas with different environments.

Another challenge will be assessing the significance of items in the collection and their desired life expectancy. This is a completely different way of working for both curators and conservators and will take a long time and much discussion to accomplish. Clearly "preservation in perpetuity", as enjoined by the British Library Act, is no longer an option – and, realistically, it never was.

El rostro cambiante del almacenamiento en la Biblioteca Británica

En este trabajo se plantea cómo la Biblioteca Británica está cambiando la manera de almacenar sus colecciones mientras se asegura de que sean almacenadas en óptimas condiciones ambientales.

La Biblioteca Británica es una de las instituciones más grandes del mundo. Con la sede principal de Londres, St. Pancras, un centro de documentación en el Norte de Inglaterra (Boston Spa) y una hemeroteca dedicada en el Norte de Londres (Colindale), comprende más de 150 millones de ítems. Las colecciones requieren un estimado de 625 kilómetros de estanterías y continúan creciendo.

A pesar de la construcción del nuevo edificio de St. Pancras, el problema del almacenamiento es permanente por lo que figura de manera destacada en las estrategias de la biblioteca, junto con la preservación a largo plazo, con énfasis en pasar a una operación en dos sedes (London St. Pancras y Boston Spa).

Al establecer esta prioridad, la Biblioteca aseguró con éxito el financiamiento gubernamental para un nuevo depósito en Boston Spa, con un edificio independiente para almacenar monografías (principalmente) y material de uso poco frecuente. El objetivo era construir un edificio que durara setenta años, sostenible en términos de funcionamiento y costos de ciclo de vida y que cumpla con las directrices británicas sobre temas ambientales, además de ofrecer almacenamiento seguro adicional al menor costo.

El edificio para monografías/material de uso poco frecuente es un diseño innovador con un almacenamiento automatizado y un moderno sistema de recuperación y prevención de incendios que albergará aproximadamente siete millones de ítems de colecciones cuando esté lleno.

Otra de las prioridades estratégicas de la Biblioteca se focaliza también en el almacenamiento, pero en un contexto más específico, para preservar y dar acceso a las colecciones hemerográficas de la biblioteca, que son las más valiosas de todas las colecciones de la Biblioteca Británica, con solo el 30% en mal estado o inutilizable. De nuevo, un nuevo edificio le da soporte a esta prioridad – la construcción de una instalación para ese fin específico en Boston Spa específicamente para periódicos.

El nuevo edificio de depósito para prensa podrá almacenar unos 128 kilómetros de periódicos (aproximadamente 287.000 ítems) nuevamente en un ambiente con un nivel bajo de oxígeno. El edificio propuesto tiene una superficie de 3.924 m^2 y es un sistema automatizado de alta densidad que funciona con una temperatura de 13°C y 40% de humedad relativa. La hemeroteca de Colindale será cerrada en 2013 después de la mudanza de las colecciones.

Este documento recuerda que las normas sobre ambientes de almacenamiento para materiales de archivo están evolucionando, pasando de especificaciones ambientales rígidas a lineamientos para el manejo del ambiente para todo tipo de colecciones.

Building a Film Preservation Solution for the British Film Institute

by Helen Edmunds Collections Manager, **Charles Fairall**[1], Head of Conservation, **Sarah-Jane Lucas**, Head of Strategic Projects and **Ron Martin**, Head of Collections Management, BFI National Archive, UK

In 2003 a report by the UK National Audit Office indicated that the BFI had significant challenges, representing genuine risk to the 330,000 can master film collection in its care. This report led to the preparation of a bid for capital funding to the UK Government which would include a wide range of measures to secure the collections and make provision, ultimately, for public access to the rich and unique screen heritage material at risk of loss.

The BFI no longer regarded photochemical duplication as viable as the prime means for preservation due to the size of the collection, the cost of preparation and the actual digitisation, the time required and the quality loss. Attention instead turned to passive conservation through radically improved physical storage conditions. We would also take the opportunity to replace rusty cans, extend barcoding, improve security and introduce an inert gas fire suppression system.
Low temperature storage would reduce the rate of decomposition and low humidity would provide an effective foil to the ravages of mould. Research and peer review led us to conclude that -5°C and 35% relative humidity (RH) should be our target climate.

We had already taken some passive preservation measures to address the most acute storage concerns. Temporary shipping containers, offering -5°C and 35% RH provided much needed capacity, but they were energy inefficient and not suitable for the storage of nitrate film. Our main safety vault, located at the Conservation Centre in Berkhamsted, gave us respectable +5°C and 35%RH storage for the bulk of the master film collection, but we knew there was still room for considerable improvement.

1. Overfull cell cans stacked two deep.

The nitrate film collection, probably the world's largest, was stored at a BFI facility in rural Warwickshire near the village of Gaydon. Here we had 12 vaults, each with 24 one tonne capacity cells. They were conditioned and designed to accommodate nitrate film but they were overcrowded, the fabric of the buildings was failing and the ageing air conditioning equipment was incapable of providing the target sub-zero climate required.

Funds were awarded, in principle, in late 2007 with the expectation that a fully reasoned business case, demonstrating far-reaching benefits to the general public across the UK, would be presented and approved. Funds were secured on this basis by late 2008.

It was recognised that at the heart of the business case for Screen Heritage UK, as the programme became known, was the urgent need to provide a long-term preservation solution for both the acetate and nitrate film masters. These collections were accommodated in different geographical locations and within an array of buildings which were largely unfit for purpose, particularly given the BFI's aspiration for sub-zero and low humidity storage.

In order to develop proposals beyond the initial feasibility work carried out to support the bidding process, a skilled team of designers was required to develop a response to meet the challenging design brief.

Assembling the team was a lengthy and formal process. As the building format and environmental conditions were unusual, if not unique, finding consultants with actual experience of this building type was difficult. Instead of insisting on such experience, the selection process sought to identify a particular approach that would bring innovation and flexibility, combined with the necessary high levels of skill and technical ability.

The outcome was the creation by June 2009 of a fresh and enthusiastic team of architects and engineers, supported by cost and project management, ready to take on the next stage of the project.
The BFI wanted to test its thinking with film archiving peers and so decided to form an "expert group" which would challenge our assumptions and contribute towards the design debate.[2] Early discussions addressed issues such as: is -5°C / 35%RH the ideal climate? What level of climate resilience should be specified for the building in the event of power loss? How should we safely acclimatise film moving in and out of the cold store?

1. Charles.fairall@bfi.org.uk

2. The expert group comprised Thomas Christensen (Danish Film Archive), Joao de Oliveira (PresTech Film Laboratories, London – a member of the design team), Tim Padfield (Freelance Consultant in Preventative Conservation, Devon, UK), David Walsh (Imperial War Museum, UK).

We also needed to consider change management for our staff and as part of this invited independent consultant Tim Padfield to present the benefits of cold and dry storage for film to colleagues.

The expert group played its part, along with BFI staff, in working with the design team to refine the vision for the creation of the future Master Film Store.

The design challenge presented by our vast, disparate and deteriorating master film collection was greater than anyone within the new design team had first imagined. The 12 month design process began with an intense period of scrutinising and questioning accepted standards, exploring precedents and benchmarks, testing design theories and then returning to first principles, before agreeing the way forward.

The brief presented anomalies, in particular the fundamental requirement to create a highly sophisticated 'freezer' building that would be both energy efficient and affordable to run and maintain. In addition, a storage design solution for both acetate film and for the highly volatile nitrate collection needed to be achieved within an extremely constrained site.

A limited amount of physical open space available for new construction coupled with the discovery that existing nitrate storage buildings would not be viable (neither technically or economically) to convert to sub-zero, led to the conclusion that acetate and nitrate film materials should be stored within the same overall structure – albeit with appropriate segregation for fire protection.

Creating a highly insulated, air-tight building envelope was essential to achieve close temperature and humidity control while at the same time minimising the use of energy. It was also vital that the film be protected by 'buffering' the impact of rapid temperature or relative humidity changes. It was clear that a material with high thermal mass would be required. The main component of the building fabric selected by the design team was therefore to be large pre-cast concrete panels assembled in a cellular configuration.

By using the largest possible pre-cast concrete panels, the number of weak points in the building envelope was kept to a minimum. This presented a particular construction challenge but contributed significantly to the achievement of an impressively low air permeability rating of 0.28m3/m2/hour which is 70% lower than an exemplar low energy building. This drastically reduced the energy required to condition the air in the vault and contributed to the building attaining a BREEAM (Building Research Establishment Environmental Assessment Method) rating of 'Excellent', a considerable achievement for a building of this type.

During the design feasibility stage, many options for size, shape and format of the building were tested by the team. The fire management principles, which included the need for nitrate cells to vent externally, had to co-exist with the desire to maintain a highly efficient air conditioning system.

The configuration with the best overall economy was a single storey structure with six large safety film cells in the centre and thirty smaller nitrate cells arranged around the periphery, separated by fire protected corridors. A modular system with standardised components was adopted for the provision of climate control with air-handling, chilling and dehumidification plant located on the heavily insulated roof. This approach was chosen to enable ease of access to all equipment, together with simplified maintenance.

The key distinction between this solution and many of the existing precedents is that the amount of nitrate material stored in each of the cells is far greater at approximately 12 tonnes per cell. The design rationale for storing larger quantities of nitrate film in efficient compact storage made clear sense but the question of the security and fire safety of this solution needed to be scrutinised and tested before the BFI was willing to proceed with this innovation.

The two driving design principles of the fire strategy for the new store were based on the ideas of prevention and containment. These key principles seek to minimise any risk of a nitrate fire occurring. In the extremely unlikely event of ignition, the building fabric, its configuration, equipment and systems would work together to contain the loss of material to a single cell, protect the safety film master collection, and of course, all personnel.

The strategy to prevent a nitrate fire is founded upon the maintenance of a sub-zero temperature environment and removal of all ignition sources. The design solution incorporates systems that have redundancy built-in, thereby ensuring that cold conditions are maintained, even in the event of power or plant failures. The high thermal mass structure of the building retains a sub-zero environment for 72 hours without the input of energy and therefore provides sufficient time for repair, replacement of failed components or connection of an auxiliary generator. As a matter of policy the nitrate cells have no electrical switches or controls inside, low energy LED lighting, passively controlled pressure relief doors and a Vesda smoke detection system, all controlled from the corridors.

To validate this strategic approach to fire prevention and detection, independent assessments were carried out by the BRE (Building Research Establishment) to evaluate the response of nitrate film, in various stages of decomposition, to electrical sparking and also the performance of systems designed to detect the combustion products of burning film. The results showed that even after continuous sparking, the film was not ignited and that existing fire detection technology would successfully detect nitrate combustion products. These assurances provided a second level of confidence that the risk of a fire occurring had been effectively eliminated through the use of considered and strategic design principles.

Fire containment is achieved principally through thick concrete twin-panel insulated construction. Within the nitrate cells this is augmented by fibres embedded in the concrete which stop surface fragmentation of the concrete and thereby maintain the overall integrity of the building's structure, should it be subjected to extreme and sustained temperatures.

In the case of fire, a damper acts to prevent the spread of flames and smoke from a nitrate cell to other parts of the building. These devices, which were designed for use in the petrochemical industry, close within three seconds and are rated to

2. Film prepped for move.

3. Loading out film from Acetate vault at Conservation Centre.

withstand a two hour fire. A special, fire resistant steel door together with the dampers, create a robust and integrated fire barrier. The six master safety film storage cells within the central portion of the store and the low voltage switchroom are each protected by an argonite gas fire suppression system.

A major feature of each nitrate cell is a large, pressure relief panel that opens outwards like a drawbridge to allow the products of combustion to escape should a fire ever occur. The pressure relief panel is held in place by two fusible links that break when a pressure of 2.5KN/m^2 is exceeded or when the temperature within the cell reaches 72°C. As there is no way of effectively extinguishing a nitrate fire, opening of the panel allows the maximum amount of oxygen to feed the fire which in turn promotes a clean and rapid burn, so reducing the risks of toxic gases.

The highly innovative strategic approach to managing nitrate fire risks was validated by external assessors. To ensure that the BFI could have confidence in its solution an independent peer review was undertaken by the BRE to check that the modelling was robust, given that more than 12 tonnes of precious nitrate film would be stored in each cell. The validation provided firm assurance that the fire engineering work was conservative in approach and was central to the decision to proceed with such an innovative design.

The BFI faced a considerable logistical challenge in preparing film materials for their move to the Master Film Store. 55% of cans were to be shipped by road from the Conservation Centre to the new vault, while the remainder had to be moved across site. The demolition, to a strict timetable, of nine of the existing nitrate vaults served to complicate matters further.

The successful delivery of collection management tasks depended heavily on identifying the right products and suppliers. The BFI tendered for film cans, barcode labels (suitable for use in sub-zero conditions) and a specialist relocation contractor. High quality project planning and resource allocation were critical to the successful achievement of a number of work packages across two sites, located 70 miles apart.

Using the BFI's collections information database it was possible to determine which materials should be moved to the Master Film Store. This work included identification and segregation of magnetic components which were deemed unsuitable for low temperature storage. It was necessary to have clean cans to ensure that barcodes would adhere. The Vaults team, trained in film

4. Master Film Store: goods entrance at the office end of building with sedum roof and some nitrate pressure relief doors. ©BFI Photograph by Edmund Sumner handling, replaced over 125,000 rusty cans, largely containing nitrate film. Over 225,000 barcode labels were applied to cans and associated with records in the BFI's new collections information database. We were able to achieve this by creative use of collections data to mass-produce barcodes along with a varied approach to label application utilising our own vaults team and staff from the logistics company, Nexus. As our old nitrate vaults were to be demolished, we had to ensure they were clear of all materials, which meant reviewing the contents of some 288 cells, resulting in curatorial and conservation appraisal and accessioning of 15,000 cans of un-acquired materials.

Some 33,850 new position barcodes were applied and a successful eight week multi-site move programme for 330,000 film cans was accomplished with the contractors delivering to a firm requirement, that to avoid condensation while in transit, a film can should not be subjected to a rapid change in temperature of more than 8°C. The movement methodology was two-fold: safety film was moved, maintaining sequence, whereas nitrate titles were divided between receiving cells so that risk of total loss was mitigated in the unlikely event of fire. As an example, the original picture negative of Herbert Ponting's Great White Silence (1924) would be stored across three separate cells.

So with the Master Film Store built and occupied, the BFI needed to ensure that operational procedures and health and safety rules were robust. A site operations manual was developed during construction and this formed a guide for the early occupation and use of the building. For example, it made assumptions about how film would be acclimatised using *Thermoclipper* crates, described how the building's security features should be operated and gave guidance on working periods in the cold storage environment. A maximum 45 minute working period in sub-zero conditions was decided upon and staff health screening was conducted on this assumption. The operations manual therefore provided a comprehensive guide to the use of the building and an induction aid for new staff who also benefit from workshop facilities, so a programme of inspection and scientific analysis of the myriad physical and chemical challenges posed by a large film collection can be carried out in close proximity to the collection.

As the film industry continues to move away from photochemical production and projection, access to these masters, which represent the highest quality elements in existence, will increasingly be made through digital means. As an example, the BFI's 2012 *Silent Hitchcock* project drew upon surviving nitrate materials, and in the case of the title, *Blackmail*, where the original camera negatives exist in good condition, high resolution 4K scanning yielded the best possible quality.

With traditional film craft skills and processes being maintained at a high standard and film scanners continuing to advance in both resolution and dynamic range, the combination of preserved original elements with state of the art technology, will provide future audiences the opportunity to experience films much closer to the original artistic intent than has previously been possible.

5. Corridor with nitrate cells to right and acetate to left in new MFS. ©BFI Photograph by Edmund Sumner

6. Safety film in new MFS. «©BFI Photograph by Edmund Sumner

The Crisis in Storage: An Old Tale… With a New Ending?

by Simon Lambert, Preservation Development Advisor, Canada

Introduction

In 1976, the "International Conference on Museum Storage" was organized in Washington, D.C. by ICOM (International Council of Museums), the United States National Commission for UNESCO (United Nations Educational Scientific and Cultural Organization), and the AAM (American Association of Museums). One of the aims of this conference was to draw attention to the diminishing resources allocated to museum storage all over the world. As a result of the meeting, UNESCO commissioned a handbook on storage planning (*Museum collection storage*), which began with a word of caution: "probably more harm has been done to museum collections through improper storage than by any other means."[1]

Twenty years later in 1995, it seems the situation had not changed significantly when UNESCO published a special edition of *Museum International* entirely about storage: "As storage is not visible, it tends to be neglected in planning and investment, where priority is given to spaces open to the public."[2]

It has now been nearly 20 years since then, and the results of the first international survey on museum storage supported by ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) and UNESCO make for a grim reading.[3] It would appear that regardless of the efforts that have been made so far to raise awareness about this issue, bad storage still remains a 'dirty little secret' for many institutions. The difference, this time, is that new user-friendly online resources are now available on the RE-ORG website (www.re-org.info) to assist smaller institutions with limited access to resources or outside expertise in tackling problems that have deteriorated over time. Although the focus here is mainly on museum storage, the basic principles also apply to collecting institutions in general, including libraries and archives.

The ICCROM-UNESCO International Survey on Museum Storage, 2011

There is a perception that storage areas found in *developed* countries must be in much better health than those in *developing* countries. However, over the last 10 years, several shocking examples of poor storage conditions in major institutions have emerged in the United States,[4,5] Canada,[6] the United Kingdom[7] and Russia[8] to name a few. But apart from these sporadic examples, until now it was difficult to get a sense of how storage was doing on a global scale. So, through a partnership between ICCROM and UNESCO, the first international online survey on museum storage was launched in 2011. The aim of the survey was to obtain a snapshot of as many institutions as possible in as many different countries as possible. To do this, ICCROM designed a short 10-minute online survey and sent it throughout its vast network of conservation professionals and institutions, throughout UNESCO's network of regional offices and permanent delegations in Paris, and throughout ICOM's regional, national and international committees. A first version was prepared in English, but rather unexpectedly, ICCROM received several spontaneous offers to translate the survey into French, Spanish, Portuguese, Italian, Japanese, Chinese, Russian, Farsi and Hindi.

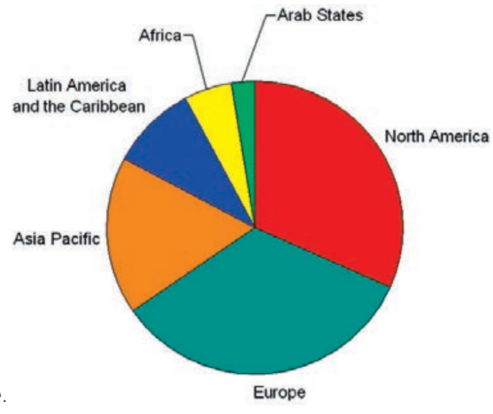
In total, 1490 responses were received across 136 countries from June to September 2011. The majority of responses came from Europe, North America and the Asia-Pacific region (Figure 1). Since representative samples were not taken of each country, the results should not be used to indicate trends between countries or regions or to compare their performance.

Given that about a quarter of the responses were from the United States alone, ICCROM isolated these results to compare them to those of the rest of the world. In the end, there was no significant difference between them, beyond a difference of a few percent at the most. A full summary of the survey results is available online (see References). Clearly, what this survey indicates is that developing and developed countries both need assistance to improve their storage conditions.

A few key figures from the survey…
1/4 museums – Circulation in storage is difficult or impossible
2/3 museums – General lack of space
1/2 museums – Lack of storage units or overcrowded storage units
1/4 museums – Inexistent or incomplete documentation
1/3 museums – Unclear responsibility of storage
1/10 museums – Object theft a major problem

RE-ORG: the multilingual online platform for endangered collections

The three-year partnership between ICCROM and UNESCO, "Preventive Conservation of Endangered Museum Collections in Developing Countries," included one component on museum documentation and one component on museum storage.



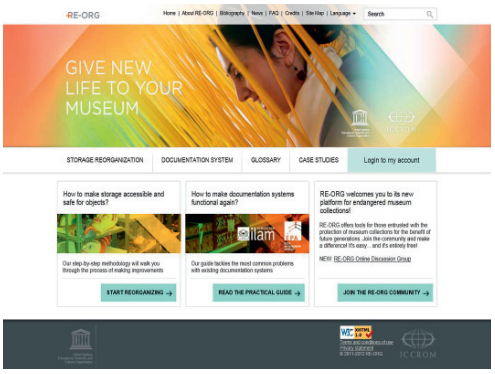
1. Regional representation in the 2011 ICCROM-UNESCO International Survey on Museum Storage.

The RE-ORG online platform (www.re-org.info) encompasses the tools and guidance that were developed as a result of this joint venture.

RE-ORG addresses a very specific gap found in the literature: while much guidance already existed about planning new storage areas or creating documentation systems from scratch, there was very little information to help institutions tackle the problem of making improvements to existing situations that may have suffered from neglect, abandonment or reduced levels of care for numerous years – with the means currently available (i.e. "storage reorganization"). In the current global economy, capital storage projects may become increasingly difficult to fund or justify, and any new resource developed for museums needed to address this reality.

The component on museum documentation was developed by a small team led by the *École du Patrimoine Africain* (School of African Heritage), a conservation training institution based in Porto Novo, Benin that serves all 26 French-, Spanish- and Portuguese-speaking countries of sub-Saharan Africa. The team produced a *Practical Guide to Documentation* – first in French, and then translated into Spanish with the assistance of ILAM (Fundación Instituto Latinoamericano de Museos) and then into English (available in all three languages on www.re-org.info).

The component on storage reorganization consists of a step-by-step methodology that can be used to assist whoever is embarking on a storage upgrade project or by educators to develop courses or presentations on the topic. The RE-ORG methodology is based on the extensive work carried out by Gaël de Guichen in over 45 countries over 40 years of involvement at ICCROM – initially as a staff member, and then as Special Advisor to the Director-General. To trial and further develop the tool, in 2008 ICCROM assembled an international team of 15 museum professionals from Angola, Argentina, Austria, Canada, Columbia, Czech Republic, India, Iran, Kenya, Peru, Philippines, Serbia, the Netherlands and Venezuela. This "Storage Task Force" met once in Rome, Italy and once in Caracas, Venezuela, but continued to work in smaller groups in between the meetings on specific aspects of the methodology. During its development, the methodology was tested in field projects in Iran and Argentina.
As of January 2012, all materials developed for RE-ORG are available online free-of-charge in English, French and Spanish following a quick, one-step registration (Figure 2).



2. Homepage of the RE-ORG online platform.

A closer look at the storage reorganization methodology

According to RE-ORG, museum storage must abide by the following core principles:

1. There is at least one trained member of staff in charge;
2. There is a basic documentation system (complete and up to date);
3. Storage areas are reserved exclusively for the collection;
4. Every object has an assigned location;
5. Every object is retrievable within three minutes;
6. Every object is movable without damaging another;
7. The building is designed or adapted for conservation.

To help users understand the key issues, analyze them and develop solutions, RE-ORG dissects storage reorganization into four areas of responsibility:

- Management
- Building & Space
- Collection
- Furniture & Small Equipment

The methodology itself is organized around four phases (see below). Each phase contains a series of individual tasks for which there exists a special worksheet. All worksheets follow the same format describing the task's importance, objectives, final outputs, required materials, as well as remarks and advice or relevant discussion points. Each worksheet is supported by examples, forms, didactic images, online resources and additional guidelines – all accessible in the right-hand menu "My toolkit" (Figure 3).

The four phases of the RE-ORG Methodology

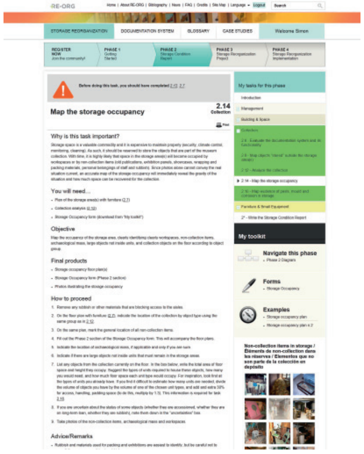
Phase 1: Getting Started
This phase outlines what one needs to have, to know or to do before beginning to reorganize storage. Users can download the Self-evaluation Tool, which is used to obtain a first overview of the situation and to identify the most important problems.

Phase 2: Storage Condition Report
Much like a conservator would do for a single object, this phase helps the reorganization team to collect information on the present situation, analyze it and produce a diagnosis before the physical reorganization can begin. The Storage Condition Report is a useful tool that can be used to obtain the institution's approval to move forward.

Phase 3: Storage Reorganization Project
Based on the conclusions of the Storage Condition Report, the reorganization team identifies all actions required to achieve the desired outcome and schedules them in a Storage Reorganization Project plan.

Phase 4: Storage Reorganization Implementation
In this phase, the reorganization team puts the plan into action, monitors its progress, and establishes appropriate systems to ensure that the improvements made will be maintained in time.

A unique feature of the website is the "Progress Log", which allows registered users to save their progress as they complete tasks of the methodology. For those who are following the



3. Screenshot of the RE-ORG storage reorganization methodology, www.re-org.info.

4. Condition of the storage areas before the reorganization.

recommended step-by-step approach, a reminder will appear when users land on a task that would requires other tasks to be completed beforehand.

Applying RE-ORG at the Catagnino + MACRO museum, Argentina

The Castagnino + MACRO in Rosario, Argentina hosts the most comprehensive collection of contemporary art in all of Argentina and is housed in a former industrial building with five grain silos. The collection comprised 725 works of art (made up of 5,700 individual pieces), some of which were very fragile, perishable or unstable. These included paintings, sculptures, three-dimensional objects, photographs, digital prints, video, digital art and installations.

The Storage Condition Report (Phase 2) highlighted the extent of the space problem: in just 6 years, the collection had tripled in size but the space remained the same! Also, incomplete documentation made it impossible to locate objects in the space efficiently. The space was showing other significant weaknesses: high humidity was encouraging the growth of mould, flaws in the building envelope were letting insect pests inside, and the layout of the space itself – along narrow corridors – made it difficult for staff to circulate with objects. Because of this, some works were being damaged and lost. Finally, the allocation of responsibilities in storage appeared to be somewhat unclear.

As part of the Storage Reorganization Project (Phase 3), a to-do list was drawn up of all the required steps in each area of responsibility (Management, Building & Space, Collection, Furniture & Small Equipment). The team found that the Condition Report was useful to help them justify the need of extra space to house the collection appropriately. Although a larger upgrade project that included the refitting of the grain silos was initially discussed, in the end, it was decided to focus on improvements that could be achieved quickly and within the existing space only. Therefore, the priorities identified were to restore order, add new storage units, upgrade the documentation system and develop any missing procedures.

The Reorganization Implementation (Phase 4) took some time because the reorganization team had to carry on with their regular usual activities on top of this project (including setting up two exhibitions), and because of the bureaucracy. The new space-efficient layout required building mezzanines, installing new lighting, and repairing the air conditioning units to reduce the mould risk and prevent the ingress of dust from the outside and from the silos above the storage areas. The delays allowed the team to focus on creating containers for the smaller, more fragile pieces – in standard sizes, to save space on the shelves. Throughout the process, the team found it useful to maintain a direct line of communication with the authorities and all team members. They also worked with the press to inform the community and build consensus. In their experience, it was absolutely critical to conduct weekly meetings and keep minutes to keep all the comity informed by email. This reorganization should be completed later in 2012.

5. The final stages of the reorganization.

Applying RE-ORG at the Slemani Museum, Iraq

The Slemani Museum is situated in Sulaymaniyah, Kurdistan, Iraq. It was founded in July 1961 as an archaeological museum, and in 1979 it was moved to its present location adjacent to the Department of Antiquities. Due to the unstable political climate, the museum was closed for most of the 1980s and 1990s and reopened in 2003. The collection counts approximately 66,000 objects (beads, coins, glass, gold, ivory, metals, terracotta, stone objects, etc.), which were mostly acquired in the past 5 years through acquisitions. So far, the museum has organized one temporary exhibition and given the conditions of storage, has only been able to approve two requests to accommodate scholars. The RE-ORG methodology was applied in the context of a weeklong workshop for the museum staff.

The Storage Condition Report (Phase 2) highlighted some of spatial issues that often arise when museum storage areas are used as repositories for incoming archaeological materials without a clear physical separation between these spaces. These problems seemed exacerbated by unassigned responsibilities for storage maintenance, large amounts of non-collection materials, a lack of appropriate storage units or containers, flaws in security and a sizeable documentation backlog (only 25% objects registered).

6. View of the storage area before the reorganization.

7. View of the storage area after the reorganization.

In conjunction with the Director of the Museum, it was agreed in the Storage Reorganization Project (Phase 3) to improve the functionality of the storage by creating a 'storage department,' with designated functional spaces for collections-related activities carried out by staff, for scholars to examine and research the objects, and one room reserved exclusively for the museum collection. Thanks to the hard work of 12 staff members who accepted to work on Friday and Saturday, all non-collection objects identified in three hours and subsequently removed in 5 hours. This represented a volume of 20 m^3 occupying about 34 m^2 of floor space! With this extra space freed up, it became possible to clean the space thoroughly, to set up a working area and to access most of the objects. The team worked on defining the collection's storage unit needs and on how to reallocate objects to other units to make more efficient use of space. Furthermore, they prepared a plan to upgrade the documentation system and create the missing elements (e.g. a functional storage location system) and to create the missing founding documents for the administration of the newly created 'storage department', such as policies and procedures. Finally, a list of minor repairs to the building was also prepared to reduce water risks, fire risks and some personal safety risks to the staff.

Using the RE-ORG self-evaluation tool, the improvements to the storage area after the reorganization could be quantified:

Area of responsibility	Score BEFORE reorganization	Score AFTER reorganization
Management	2 (serious risk)	23 (small improvements needed)
Building & Space	31 (small improvements needed)	46 (situation seems fine)
Collection	21 (full reorganization needed)	28 (small improvements needed)
Furniture & Small Equipment	7 (serious risk)	30 (situation seems fine)

Upcoming storage reorganization workshop at the Canadian Conservation Institute

In Canada, museum storage suffers from the same problem as elsewhere in the world. In response to the growing demand for training on storage management issues from Canadian museums, the Canadian Conservation Institute (CCI) is in the process of updating its two-day workshop on storage planning, which will now be called "Storage reorganization". The change in name also indicates a shift in focus. Fundamentally, the workshop will be a practical introduction to the RE-ORG methodology, and on how to apply in a real situation. To allow participants to do a maximum of hands-on work, collaborations will be sought with small museums across Canada to host the workshop and allow a group of 10-16 participants to work in its storage area to assess the situation, present a condition report and proposed plan of action to the museum. The workshop will have interactive presentations, discussions and practical activities and be given in Canada's both official languages, French and English as of late 2012. CCI hopes these efforts will contribute to improving storage conditions across the country in the long term and to build capacity in this specific area of collections management.

Acknowledgments

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Contact

For more information on RE-ORG, the ICCROM-UNESCO partnership and the International Survey on Museum Storage, visit ICCROM's website (www.iccrom.org) or write to collections@iccrom.org. For more information on CCI's workshops, research and services, visit the CCI website http://www.cci-icc.gc.ca or contact simon.lambert@pch.gc.ca.

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Long-term preservation at the National Library of France (BnF): Scalable Preservation and Archiving Repository (SPAR)

by Thomas Ledoux, Software Engineer, IT Department, SPAR Project Manager, BnF, France

The National Library of France (BnF) has the mission to collect, preserve and give access to all the published material in France. To this aim, the legal deposit has been extended to the different forms of publishing from the printed material in 1537, to electronic documents in 1992, as well as the Internet in 2006.

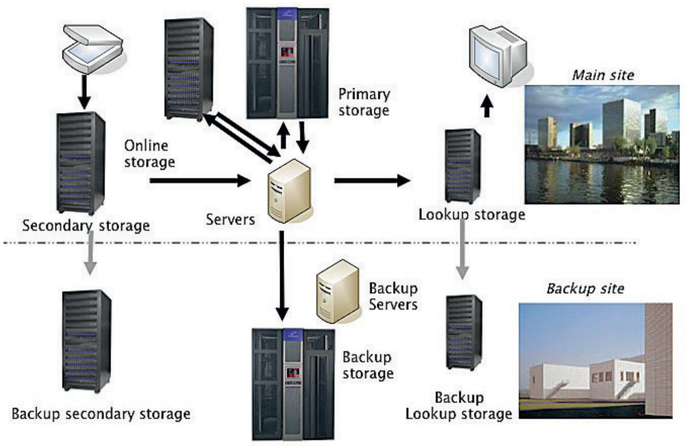
To preserve all this digital cultural heritage, the BnF has designed a Scalable Preservation and Archiving Repository (SPAR). This central repository has to handle the diversity (media, formats, departments …) by taking inspiration from good practices and standards. The key requirements of the system where:
– OAIS[1] compliance,
– modularity and scalability,
– abstraction,
– use of well known formats and standards,
– use of open-source technical building blocks.

Infrastructure

The first move has been to acquire all the infrastructure needed in order to handle this vast amount of data. In order to be resilient, it was decided to use two geographically disperse locations to install all the hardware, with an efficient way of communicating between this 2 sites. Based on the OAIS model, three different kinds of storage were anticipated:
1. the secondary storage where the packages are submitted,
2. the primary storage where the packages are archived,
3. the lookup storage where the packages are disseminated.
For the first and third kind, "network-attached storage" (NAS) is used since the volume can be limited and performance is the main factor.
For the primary storage, tape libraries are preferred since the volume can be easily expanded while the cost remains affordable. Another advantage is the fact that tape technologies can be mixed to ensure that there will not be any vendor locks and that there will be no single point of failure: currently we use LTO5 and T10000B tapes. Some NAS are also in the party when a third copy is required for the most valued documents.

A schema of the infrastructure can be found above.

Lastly, all the system works on a dedicated network and the pieces of hardware are physically located in rooms that are accessible only to designated employees.



Storage abstraction layer

Once this infrastructure is in place, a technical module, called "Storage Abstraction Service", has been built in order to guarantee the independence from the physical infrastructure by ways of storage units. Those units are defined by a set of characteristics and services which allows the match with a particular storage component or more usually a set of those elements (for example, the association of a pool of tapes with a partition in a disk array).These different units are defined by the administrators using the storage components they have to match at best the requirements defined by the policies.

The SAS, directly derived from the iRODS[2] middleware, implements a set of rules in order to allow transparently:
– the management of multiple copies,
– the regular audit of the data,
– the refreshment of the media,
– the migration of the media.

See the illustration at the top of page 19.

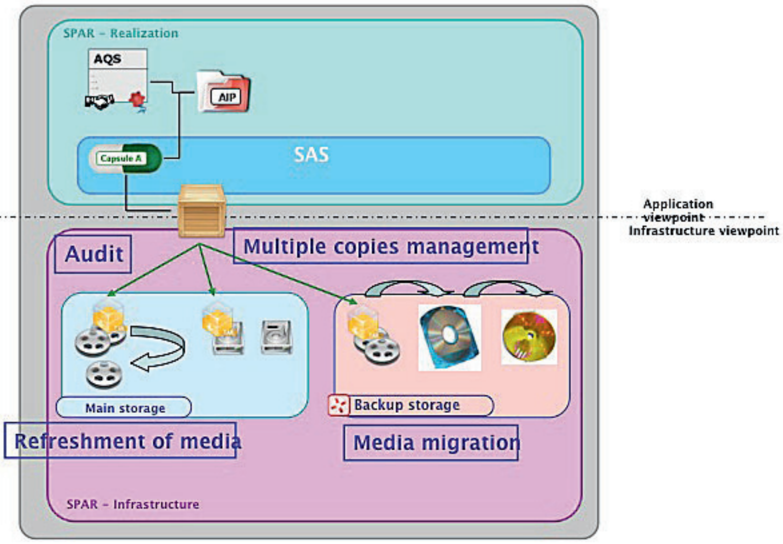
Software

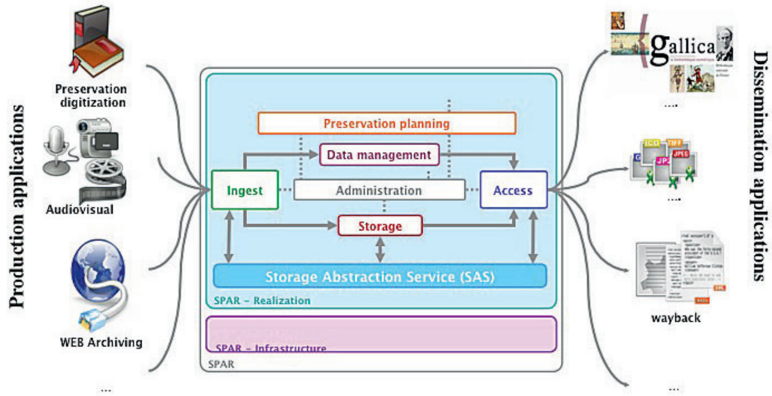
Having a robust infrastructure is just the beginning. On top of it, an OAIS compliant software needs to process all the incoming packages, audit the archived ones, and disseminate appropriately the required ones.

The BnF designs such a system using OAIS not only as a reference model but also as a functional requirement. By taking this view, we were able to match each entity with a software module, guaranteeing, through this modularity, that the system will be able to evolve in the future by replacing the obsolete parts by new ones. The core system is then divided in generic modules:

1. The OAIS model is also known as the ISO 14721:2003 standard.

2. See http://www.irods.org for technical details





– The Ingest module receives the data to ingest (SIP) from the producers according to the ingest policy negotiated first with the administration of the Archive. Once the ingest package validated through the different controls, the data is packaged for archival (AIP) before being given to the storage.
– The Storage module ensures the AIPs are appropriately stored in conformance with the archival policy (number of copies, location of copies…) and is audited in a regular base in order to guarantee the integrity of the data.
– The Data Management module ensures the functions and services related to the enrichment, the preservation and access of the *Descriptive Information* (which identifies and describes the collections of the Archive) and to the administrative data needed to manage the Archive.
– The Access module is in charge of supplying data to the user community to be disseminated as packages called DIP.
– The Administration module organizes all the archival procedures and monitors their smooth running. To achieve this, it's in relation with the producers, the users as well as all the others modules which it orchestrates the work; it ensures the right sequencing of all the functions of the Archive and can bring back information.
– The Preservation planning module (work in progress) allows the definition and the monitoring of the formats and standards used by the SPAR system. It's fed by information coming from the business intelligence tool as well as the format registry so that it can monitor the changes of formats or plan the evolutions on storage or policies.

In order for this generic core to work in front of the variability and heterogeneity of the data have to be dealt with. So the documents are classified in different tracks. Each track is defined by the relation between the digital objects and the archival system, independently of any given organization. This relation encompasses juridical, technical as well as business factors, and each track determines what kind of operations the repository is allowed to do in order to ensure the long-term preservation of the data. Currently, seven tracks[3] are envisioned for all the material of the library:

– preservation digitization: material digitized by the library from analog material for preservation purposes
– audiovisual: material ingested for legal purposes in the audiovisual area being it analog or digital
– negotiated legal deposit: material ingested for legal deposit purposes, collected through particular processes to be negotiated with producers
– automated legal deposit: Web archiving harvested through automated processes (crawlers)
– records management: material created in a digital form by the library during its own activities
– third party archiving: material archived for the account of a third party
– acquisitions: material acquired on a fee-based basis or collected through gifts, legacy…

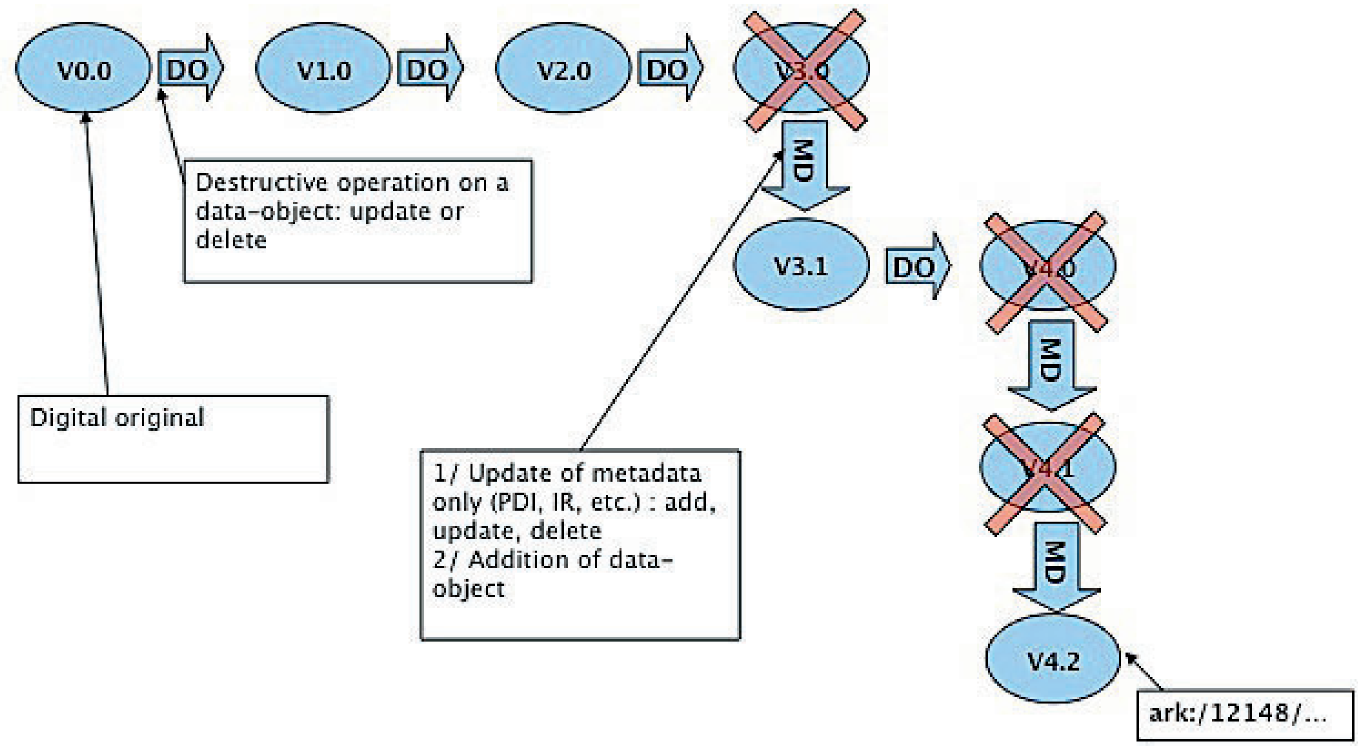
To accept these different materials, a service level agreement is negotiated for each new track that defines what can be accepted (ingest SLA), how the material is kept (archive SLA) and the ways of accessing (dissemination SLA). Once the SLA is in place, a reference package is built which is itself ingested in the system before any data can be accepted.

Data Model

In order to be able to preserve the digital documents, the archival packages (AIP) are made of different kinds of information, classified in the system according to their content and their role in the functioning of the Archive.
In SPAR, the main following concepts are distinguished:
- data-object, which corresponds to the digital files to be preserved.
- metadata, which corresponds to the information needed to understand the data-objects (in particular, the representation information and the Preservation Description Information).
- packaging, which describes the links real or logical between the different components stored in a package on a media. In SPAR, it's expressed with a METS[4] manifest.

3. Tracks may be further refined into channels, when technical differences need to be followed.

4. See http://loc.gov/standards/mets



Concerning the metadata, the SPAR system uses standard schemas, among which we can mention:

- Dublin Core (http://dublincore.org/documents/dces/) for the descriptive information, i.e. the description of the object that is archived,
- MIX (http://www.loc.gov/standards/mix/) to code the technical metadata for image files,
- textMD (http://www.loc.gov/standards/textMD/) to code the technical metadata for text files,
- MPEG7 (ISO/IEC 15938) to code the technical metadata for audio or video files,
- containerMD (http://bibnum.bnf.fr/containerMD-v1/) to code the technical metadata for web archive files,
- PREMIS (http://www.loc.gov/standards/premis/) for the provenance information, i.e. the documentation of the history of the data-objects

Moreover, over time, it may be necessary to act on archival packages either to make a correction or, more presumably, to migrate to new formats when obsolescence occurs.
In SPAR, the archival package follows a lifecycle that depends on the transformations that are applied: see the figure above.

So a unique ARK (Archival Resource Key) identifier[5] is assigned to each digital document. The access to a particular instance of an archival package is made by supplying the exact version and release wanted. If this information is not provided, the last one is given back.

Main facts

The whole system is now in operations since May 2010. So far (September 2012), more than 400 000 packages have been archived from the last programs of digitization, amounting to more than 280TB of raw data, replicated. Among the archived packages, the size varies from a few kilobytes to more than 135GB for some manuscripts digitized in 600 dpi full color.

During these two years of operations, since the infrastructure was acquired first, our first complete technical migration has taken place to incorporate new generation of tapes. At the time of the migration, 78TB were migrated while 26TB of new packages were ingested demonstrating the correct behavior of the storage abstraction layer.

Finally, the system is able today to ingest packages coming from monographs, periodicals, still images, audio, video, web harvesting, third party packages.

5. See http://www.bnf.fr/en/professionals/other_international_identifiers/a.ark_other_identifiers.html for details on the uses of ARK in the library.

Digital Preservation, Mass Storage and Facilities at The Church of Jesus Christ of Latter-day Saints

by Gary T. Wright, Senior Product Manager of Digital Preservation at the Church History Department of the Church of Jesus Christ of Latter-day Saints

Introduction to the Church of Jesus Christ of Latter-day Saints

The Church of Jesus Christ of Latter-day Saints is a worldwide Christian church with more than 14.4 million members and 28,784 congregations. With headquarters in Salt Lake City, Utah (USA), the Church operates three universities, a business college, 138 temples, more than 4000 family history centers, and thousands of seminaries and institutes of religion around the world that enroll more than 700,000 students in religious training.

The Church has a scriptural mandate to keep records of its proceedings and preserve them for future generations. Consequently, the Church has been creating and keeping records since 1830, when it was organized. A Church Historian's Office was formed in the 1840s, and later it was renamed the Church History Department.

The Church History Department

Today, the Church History Department, which is housed in the Church History Library shown in Figure 1, has ultimate responsibility for preserving records of enduring value that originate from the Church's ecclesiastical leaders, Church members, various Church departments, the Church's educational institutions, and its affiliations.

With such a broad range of record sources, the array of digital record types requiring preservation is also extensive. However, the vast majority of storage capacity in the Church's digital preservation archive is allocated to audiovisual records.

1. Church History Library at Temple Square in Salt Lake City.

Developed in 2009, a Collections Development Policy provides the following criteria for Church History acquisition of records:
1. Applicability to the Church History Department's purpose
2. Provenance (i.e., the collection's origin, authenticity, and history of ownership)
3. Historical significance
4. Usefulness, including expected frequency of access
5. Relative value compared to existing Church History holdings
6. Anticipated costs of acquiring, processing, providing access to, and preserving the records
7. Physical condition (if not born-digital) and prospects of long term viability
8. Legality of title

As may be inferred from these acquisition criteria, virtually all records that are acquired by Church History are candidates for preservation because the criteria ensure that only records of historical value—and thus enduring value—are accepted.

When Church History acquires records, whether donated or created by Church organizations, it takes over *stewardship* of those records. In effect, the donors and Church organizations transfer responsibility for preserving their records to the Church History Department.
In some cases, a department's records management plan calls for certain records to be archived that do not fit Church History acquisition criteria. In these cases, Church History's outreaching, cooperative approach to digital preservation accommodates the needs of these departments regardless.

However, a different stewardship model applies to these records. In effect, the Church History Department makes its digital preservation system available as a *service* to archive them.

The digital preservation service model requires that the producer department (*i*) be responsible for the master catalog of these records, (*ii*) provide required preservation metadata, and (*iii*) assist with future file format transformations.

In return, the Church History digital preservation operations team manages the records once they have been successfully ingested into the system.

Church Audiovisual Capabilities

Over the last two decades, the Church has developed state-of-the-art digital audiovisual capabilities to support its vast, worldwide communications needs.

To illustrate, semiannual General Conference meetings are broadcast in high definition video via satellite to more than 7,400 Church buildings in 102 countries. The broadcasts are simultaneously translated into 32 languages. In addition, the meetings are streamed live on the Church's websites. Ultimately, surround sound digital audio tracks for more than 90 languages are created to augment the digital video taping of each meeting—making the Church of Jesus Christ of Latter-day Saints the world's largest broadcaster of languages.

Because of their exalting and enduring value, General Conference videos, along with associated audio tracks, are being preserved digitally as Motion JPEG 2000 files wrapped in MXF containers.

Other types of digital audiovisual records that are being, or will be, preserved include *(i)* weekly broadcasts of *Music and the Spoken Word* (each of which features an inspirational message and music performed by the Mormon Tabernacle Choir and the Orchestra at Temple Square) and *(ii)* free Bible videos of the birth, life, death, and resurrection of Jesus Christ that can be downloaded at biblevideos.lds.org. As another example, a 560 gigabyte movie that is being shown daily on Temple Square in Salt Lake City will also be preserved.

The Publishing Services Department, which supports the Church's audiovisual needs, generates multiple petabytes of production audiovisual data annually, including the records discussed above.

About 40% of Publishing Services' audiovisual records are targeted for preservation. Some are acquired by the Church History Department; the others are preserved under the Church History digital preservation service model. In addition, a large backlog of digitized films is currently being ingested into the Church's digital records preservation system.

In just ten years, Publishing Services anticipates that it will have generated a cumulative archival capacity of more than 100 petabytes for a single copy.

This means that the Church's digital preservation archive for audiovisual data will become one of the largest in the world within a decade. And all the other Church records of enduring value will add to the total capacity of this rapidly growing digital archive.

Choosing Storage Media for the Church's Digital Archive

As with any other digital preservation operation, the Church must minimize the cost of preserving its valuable digital records for sustainability reasons. One way to help accomplish this goal is to minimize the total cost of ownership of archival storage, especially when planning for a multi-petabyte archive.

Understanding this critical need, an internal study was performed in 2008 to compare the costs of acquisition, power, data center floor space, maintenance, and storage administration to archive hundreds of petabytes of digital records using disk arrays, optical disks, virtual tape libraries, and automated tape cartridges. The model also incorporated assumptions about increasing storage densities of these different aerial technologies over time.

2. Components of the Church's Digital Records Preservation System (DRPS).

Calculating all costs over a ten year period, the study concluded that the total cost of ownership of automated tape cartridges would be 33.7% of the next closest storage technology (which was disk arrays).

Consequently, the Church currently utilizes automated tape cartridges for archival storage today. IBM LTO-5 and TS1140 tape drives, housed in IBM TS3500 Tape Libraries, are currently in production.

Eventually, enterprise tape drives (such as the TS1140) may be used exclusively in order to minimize the footprint of tape libraries housed in Church archive facilities. A TS1140 tape cartridge currently holds up to 4 terabytes of uncompressed digital data (native capacity), and a single TS3500 Tape Library can store up to 60 petabytes (native capacity) of archived digital records.

Building the Church's Digital Records Preservation System

Following extensive testing (including scalability testing), Ex Libris Rosetta was implemented as the foundation of the Church's Digital Records Preservation System (DRPS), as illustrated in Figure 2.

Rosetta provides configurable preservation workflows and advanced preservation planning functions that conform to the "Reference Model for an Open Archival Information System (OAIS)."[1] However, Rosetta does not provide a storage layer to function as a digital archive with replication capabilities. Instead, it writes a single copy of an Archival Information Package[1] (AIP—the basic archival unit) to a network file system (NFS) storage device for permanent storage. An appropriate storage layer must be integrated with Rosetta in order to provide the full capabilities of a digital preservation archive, including AIP replication.

After investigating potential storage layer solutions, NetApp StorageGRID was selected to provide desired Information Lifecycle Management (ILM) capabilities. In particular, StorageGRID's data integrity, data resilience, and data replication capabilities were attractive.

In order to support ILM migration of AIPs from disk to tape, StorageGRID utilizes IBM Tivoli Storage Manager (TSM) as an interface to the tape libraries.

DRPS also employs software extensions developed by Church Information and Communications Services (shown in the reddish boxes in Figure 2). These extensions enhance automated ingest and data integrity capabilities of DRPS.

DRPS Operations

DRPS is operated as a dark archive—meaning that delivery of requested records (other than records that have digital rights for public access) is only provided to the department or institution that produced the records. Furthermore, authorized access requests are serviced by DRPS staff; thus producers of records have neither discovery of, nor direct access to, the DRPS archive. This arrangement enhances security of the archive.

To enable viewing of archived records that do have digital rights for public access, a second instance of Rosetta has been implemented, in conjunction with Ex Libris Aleph (integrated catalog) and Primo (discovery tool), to function as the online Church History Library (history.lds.org).

This second Rosetta system is called the Digital Collections Management System (DCMS). Records with digital rights for public access are currently being loaded into DCMS independent of DRPS. In the future, the DPRS Ingest Tools will allow records to be submitted simultaneously to both DRPS and DCMS. Records going to DRPS will be high resolution preservation masters, while records submitted to DCMS will be derivatives of the masters having resolutions appropriate for internet access.

The Church History Integrated Catalog, based on Aleph, is the master catalog of Church History-acquired records in both DRPS and DCMS. As stated previously, producers of records that utilize the DRPS service model to preserve their records are responsible to maintain their own master catalog of records in DRPS. For example, Publishing Services uses its Media Asset Management System as the master catalog of archived DRPS records that are not acquired by Church History.

DRPS Today

Prior to putting DRPS into production, Rosetta was tested in a proof of concept project called the Church History Interim Preservation System (or CHIPS). CHIPS used only NFS disk for archival storage. After CHIPS test results proved to be satisfactory, the system shown in Figure 2 was placed into production.

DRPS has now been in production for a year and a half. Total archive capacity (encompassing dual copies of each AIP) exceeds 100 terabytes. A history of DRPS archive capacity through mid 2012 is provided in Figure 3 below.

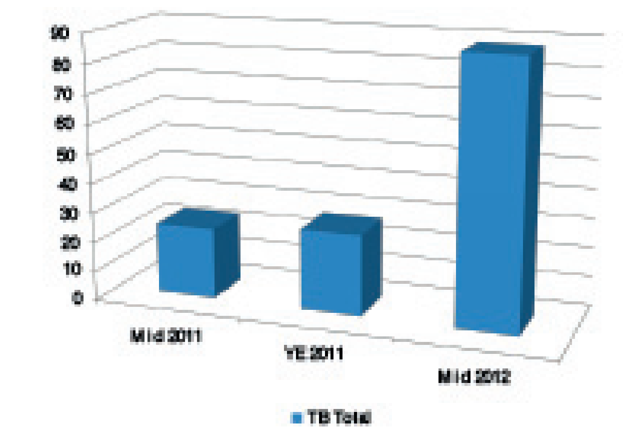
The archive capacity shown for mid 2011 in Figure 3 resulted from re-ingesting records from CHIPS—a relatively straightforward task. The modest growth between mid 2011 and year end 2011 reflects the realities of (i) learning the art of digital preservation, (ii) helping producers make preparations for digital preservation, and (iii) submitting records manually into Rosetta. Automating submissions became a high priority for the DRPS development team during this time.

Once the development team integrated the automated DRPS Ingest Tools referenced in Figure 2 with Publishing Services' Media Asset Management System (during the first half of 2012), DRPS archive capacity exploded—more than tripling in less than six months! This was a direct result of commencing automated ingest of the backlog of digitized films mentioned previously.

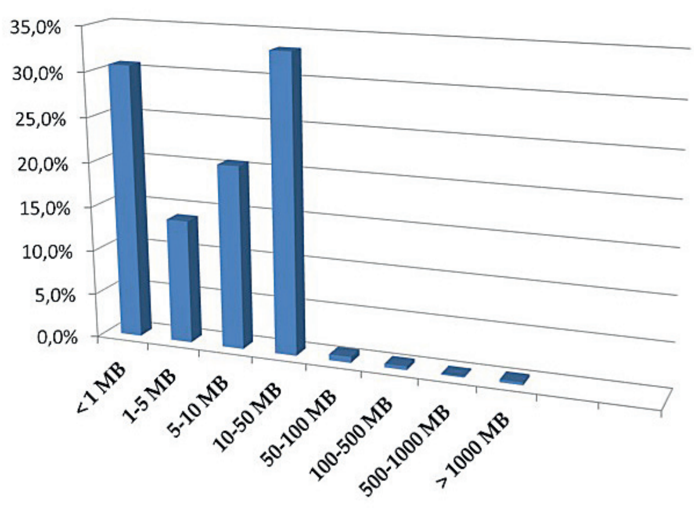
DRPS Ingest Tools fully automate the following workflow steps:

1. Open a batch of Submission Information Packages[1] (SIPs).
2. Calculate and add SHA-1 fixity information for each SIP if not already included.
3. Extract descriptive metadata from the appropriate master catalog.
4. Submit the enriched SIPs for ingest into Rosetta.
5. After successful Rosetta processing, return the resulting DRPS persistent IDs to the appropriate master catalog so the preserved AIPs can be discovered.

A recent snapshot of the DRPS archive showed that 1,112,969 files had been preserved in DRPS at the time. Figure 4 summarizes the relative sizes of these files.



3. History of DRPS Archive Capacity.



4. Distribution of File Sizes in the DRPS Archive Snapshot.

When the DRPS operations team preserves records that are produced by ecclesiastical leaders, Church departments, the Church's educational institutions, and its affiliations, the preservation file formats shown in Table 1 are requested. If the producer cannot provide these file formats, the DRPS operations team transforms, if possible, the producer files into the desired formats.

Type of Record	File Format(s)
Text	PDF/A-1b
Image	Lossless JPEG 2000 or Uncompressed TIFF
Audio	WAVE Broadcast
Video	Motion JPEG 2000 wrapped in MXF container

Table 1. DRPS Preferred Preservation File Formats.

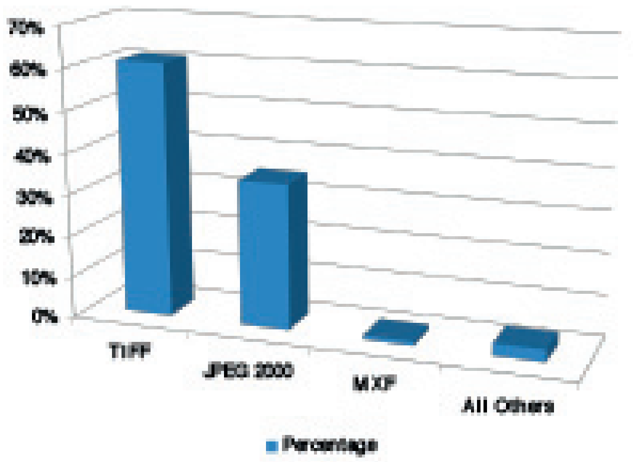
Of the 1,112,969 files identified in the recent DRPS snapshot mentioned above, distribution of the files formats is shown in Figure 5.

The Church History Department is currently decentralizing in order to start collecting personal records from members of the Church around the world. All digital records of Church historic value, whether born-digital or digitized, will be sent to the Church History Library in Salt Lake City so the records can be preserved in DRPS and made accessible online via DCMS.

Since the persons collecting and digitizing these records are volunteers with limited digital preservation skills, the list of file formats accepted for preservation in DRPS has been lengthened.

The Granite Mountain Records Vault

Many Church physical records and artifacts of priceless value are currently stored in the Granite Mountain Records Vault (GMRV). This unique facility features six tunnels that are bored into the side of a solid granite mountain (one of several prominent mountains that surround and protect the Salt Lake Valley). The tunnels have ambient conditions that are naturally conducive to physical records preservation. For nearly fifty years, the GMRV has provided secure archiving of Church records and historical artifacts that are of enduring value.



5. Distribution of File Formats in a recent DRPS Archive Snapshot.

6. Granite Mountain Records Vault.

One unique collection archived in the GMRV is the largest collection of family history records in the world. Comprising more than 2.4 million rolls of microfilm, this collection contains more than 3.1 billion images of historical and vital records that originated in more than 200 countries. The microfilmed images are presently being digitized for public access free of charge at the Church's FamilySearch website (familysearch.org).

In order to efficiently preserve the burgeoning capacity of digital records the Church is now generating, plans are being finalized to renovate the Granite Mountain Records Vault for digital preservation. The renovation includes a significant redesign and upgrade of the electrical, mechanical, and communication systems in the facility in order to equip two of the vaults exclusively for digital preservation storage media, and also to improve security and fire protection.

These special vaults, which will become the Church's "deep" digital archive, will be physically isolated from the other four vaults in the facility. Such isolation will allow optimum archival environmental conditions to be consistently maintained for the automated tape cartridges that will be housed in the vaults. Isolation will also provide a high degree of physical security.

If specified environmental conditions are consistently maintained, IBM LTO-5 and TS1140 tape cartridges have an estimated archival life of up to 30 years. While the Church does not currently plan to keep DRPS tape cartridges for 30 years (5 to 10 years is the current target so tape aerial density improvements may be leveraged), GMRV renovation plans call for optimum archival environmental conditions for tape regardless because of uncertainty of the future. The GMRV digital preservation vault environmental targets are:

• Temperature 65°F (18°C)
• Relative humidity 40%

Also, if cartridges are transferred between locations and/or environments, they must be given at least 24 hours to reach temperature and humidity equilibrium in the new location and/or environment before they are written or read.

The DRPS development team has been evaluating software products that provide monitoring (with automated alerting) of the health and integrity of DRPS tape drives and tape cartridges. This capability is desired for the DRPS archive in order to enable proactive management and corrective action of these tape resources before hard failures occur. DRPS tape cartridges will be monitored to assure that the following maximum usage restrictions are not exceeded:

• 250 full cartridge reads/writes
• 10,000 cartridge loads
• 25 years archival life

New Active Preservation Facility

An "active" preservation facility (APF), to be located in a different disaster zone from the GMRV, is also being planned. This building will provide environmental, fire protection, and security facilities similar to the deep archive in the GMRV, and will allow more copies of the Church's rapidly growing collection of priceless digital records to be preserved. Current plans call for dual copies of archived records to be stored in both the GMRV and the APF.

The APF archive will be the primary repository used to send copies of preserved records to authorized requestors. Both facilities will archive the same records, but the deep (GMRV) archive will be used for access only if the active archive is unable to service an authorized access request.

The APF will not be a typical data center; rather, it will be constructed exclusively to archive the Church's digital records of enduring value. For example, the tape libraries in the current design are to be housed underground on the lower level of the facility. Underground storage provides superior security and protection against natural and man-made disasters.

The upper level of the current APF design will contain a small data center to hold the digital preservation IT equipment. The reasoning for allowing this equipment to be located on the upper level is that it can be replaced relatively quickly after a disaster, while the data on tape cartridges will take months, if not years, to replace.

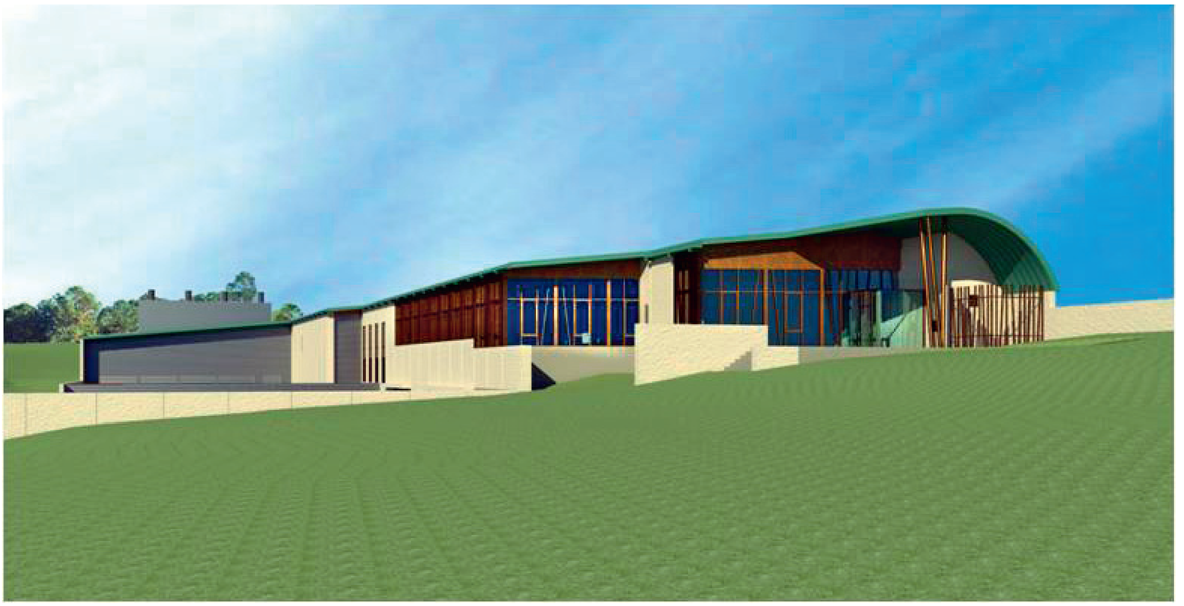
When completed, these redundant, state-of-the-art archive facilities will help the Church safely and securely preserve digital records of exalting and priceless value so they can be shared with the world—now and in the future.

Conclusion

The Church of Jesus Christ of Latter-day Saints is making a considerable investment to renovate and build the digital archive facilities and digital records preservation system described in this article. The benefits of preserving the Church's exalting and inspiring records cannot be measured in financial terms, however. Those benefits include building character, strengthening families, linking pepople of all nationalities, races, and religions with their ancestors, and preserving the heritage of mankind – all of which are designed to foster both personal and family happiness.

References

1. CCSDS 650.0-B-1BLUE BOOK, "Reference Model for an Open Archival Information System (OAIS)", Consultative Committee for Space Data Systems (2002).



7. Active Preservation Facility design concept. Courtesy of Integrated Design Group.

A Systematic Approach to Selecting Inexpensive Conservation Storage Solutions

by **Paul Garside[1],** Conservation Scientist, and **Lesley Hanson**, Conservator, The British Library

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The appropriate storage of heritage artefacts is vital to their long-term survival, but selecting suitable storage solutions is not always easy due to the number of potentially conflicting factors that must be considered. For example, the method of housing should be compatible with both the objects themselves and with the local environment; it must offer adequate support and protection; it should ideally be inexpensive, readily available and easy to use. Following the discovery of objects in the British Library's collection which were showing initial signs of damage due to inappropriate storage, a systematic approach to selecting and assessing potential housing solutions was devised, as reported herein. A particular aim was to use containers, materials and testing regimes that could be sourced easily and affordably, thus permitting the rapid rehousing of all of the items identified as being at risk. This approach also places such test protocols and storage solutions within the reach of smaller collections with limited budgets and resources.

Introduction

The British Library, like many other heritage institutions, houses a very wide variety of artefacts that form an important part of our cultural heritage. Part of the Library's remit is to ensure their survival for future generations. To do so requires a combination of conservation (both interventive and preventive) and good curatorial practice, to ensure the suitable and sympathetic repair of damage, appropriate housing and storage, and the limitation of future risks.

The deterioration of collections has a number of clear causes, one of which can unfortunately be the steps taken to preserve them. The case study presented below is a perfect example of this, and gave rise to the work outlined in this paper: During a survey of some of the items in the Library's collection damage was observed, and on examination it appeared that this had largely been caused by unsuitable storage and handling in the past, specifically in this case the use of housing materials which were intrinsically inappropriate although they had been employed in line with the best practice of the time.

Damage to objects generally results from the presence of harmful chemicals or inappropriate environmental conditions, which can cause and sustain a variety of degradative reactions. The factors that lead to damage will vary significantly depending on the composition and structure of individual items, and neighbouring objects within a collection may be subject to deterioration by markedly different reagents and mechanisms.

The problem of inappropriate storage has three main causes. The first of these is the widespread adoption of BS5454 (Recommendations for the Storage and Exhibition of Archival Documents), which specifies storage conditions of 16-19°C, 45-60% RH, adequate ventilation and circulating air free from pollutants, and controlled light intensity excluding UV radiation (British Standards Institution, 2000). This standard was devised for archives of paper and parchment documents, but is not necessarily suitable for all collection materials. The relatively high humidity has the potential to be particularly problematic for sensitive metals, for example. This effect may be exacerbated in areas where collection items of different types are mixed, especially if the localised environment is adjusted to suit the predominant material types, thereby putting minority materials at risk.

Damage may also potentially result from attempts, for reasons of budget, convenience and availability, to adopt a limited range of storage systems, mounts, etc., for the entire collection. As with the difficulties encountered if a single environmental protocol is employed, damage may result from the use of storage materials which, whilst appropriate for the majority of collection items, are inappropriate for some specific objects and artefacts.

The final part of the problem arises not from understandable attempts at unifying and simplifying collection policy, but from the use of materials and conditions which should not have been employed regardless of the nature of the collection items. In most cases this is due to the use of materials which are at hand at the time, combined with a lack of understanding of the way in which these will interact with the collection items. Examples include the use of adhesives that emit volatile acids over their lifetime, foams that are prone to degradation and which will release aggressive chemical species in the process, boards and papers that are not acid-free, etc.

The first element can be remedied by ensuring that each type of collection item is housed in its own appropriate environment. This ideal, however, is rarely achievable given limitations imposed by resources, space, collection management policies and building infrastructure. The latter two aspects are easier to address, by ensuring that storage solutions are appropriate to the objects they house. However, this requires that both the objects themselves and any materials to be used in their storage are ad-

1. paul.garside@bl.uk

equately characterised, and any potential interactions between them understood. This may result in additional protective measures being required such as desiccants or barrier layers.

Although the work presented here stemmed from a specific set of inappropriately housed and thereby damaged objects (as outlined in the case study below), it was decided to approach the problem in a systematic manner that could be applied more widely in the future. This approach was divided into four broad phases, which are addressed in greater detail subsequently:

- Understanding the object and its susceptibilities.
- Selection of potential new storage solutions.
- Assessment of stability and compatibility.
- Provision for long-term monitoring and assessment.

A particular aim of the work was to assess the extent to which inexpensive, readily available storage solutions (for example, food grade storage containers) can be used in place of the traditional resource - and labour-intensive methods often adopted in the past. If these kinds of storage systems prove to be suitable, this will enable problematic collection items to be rapidly rehoused without significant costs, thereby making such solutions available to any parts of the collection that require them, rather than having to prioritise those items deemed most valuable or most at risk, whilst leaving others to continue to degrade. Such an approach will also be of particular value to small collections with limited funding and resources, where traditional approaches may be unfeasible (and where problems are often exacerbated by poor environmental conditions caused by older or less suitable buildings). Similar work has also been carried out into the use of non-woven surgical fabrics as inexpensive and readily available storage materials and barrier layers during conservation treatments (Hernandez-Gomez, 2006).

In order to assess the suitability of these materials for the long-term storage of collection items, a number of complementary tests were carried out. Each of these tests is simple to carry out and readily available with minimal specialised equipment. In combination, they give a good indication of the likely short- and long-term behaviour of the materials. These tests were as follows:

- Short-term off-gassing of volatile acids, using appropriate test strips.
- Long-term off-gassing of volatile acids, oxidants and sulphur compounds, via Oddy testing.
- Surface pH measurements.

Understanding the Object and its Susceptibilities

The first step in the formulation of a new storage strategy for an object is to understand its material composition and structure, and how this will influence its long-term stability and susceptibility to degradation. For example, metals are generally at risk in moderate to high humidity environments, but most organic materials require at least moderate humidity to prevent desiccation and fragility. These factors will vary on a case-by-case basis (May and Jones, 2006). Once the nature of the object is appreciated, the conditions best suited for its storage can be determined.

Selection of New Storage Solutions

Storage materials should be chosen to allow for the susceptibilities and requirements of the objects they house. Factors to consider include the chemical composition of material; whether the storage solution needs to be airtight; if additional protective measures are necessary (acid scavengers, desiccants, etc.); and if special handling protocols need to be employed.

In general, polymers such as polyester (PET), polyethylene (polythene), polypropylene, polycarbonate, polystyrene and polymethylmethacrylate (Perspex) are all suitable for storage systems as they are chemically stable so are unlikely to degrade over time or release aggressive volatile compounds. Many inexpensive and readily available food grade containers, for example, are made of these materials for exactly the same reasons that make them suitable for housing collection items. The identity of the component polymer can often be discovered by markings or labels on the container itself, such as the SPI resin identification coding system (American Chemistry Council, 2011), but if this is not the case, it may be necessary to approach the manufacturer for more information or carry out further testing using a technique such as infrared spectroscopy.

Additional measures will also have to be considered. For example, if the housing is required to be airtight, is an additional seal of some sort required? If so, then the compatibility of this component will also have to be determined. Is a foam cradle or other support necessary? In this case, it must not only offer sufficient support but also be chemically stable (polyethylene foams such as Plastazote are generally acceptable, but polyurethane foams, commonly used for domestic applications, are prone to degradation and should be avoided). Any papers, boards, fabrics or polymer sheets which are to be used must also be individually considered with respect to both the object and the local environment. Adhesives are particularly important as many are prone to acidic off-gassing, even if they are promoted as being of conservation grade (Stevens et al., 2011). Limited production of volatile acids may be acceptable if the object is in a well ventilated area, but if it is housed in an airtight container this will rapidly prove to be problematic.

Methods of handling objects should be considered - for example, is it appropriate to wear cotton or nitrile gloves, to prevent transfer of sweat or moisture?

Finally, active protection should be addressed. If the item is moisture sensitive but cannot be placed in a low humidity environment, then it is advisable to ensure that the container is airtight and employ a desiccant (for example, silica gel), thus creating a more appropriate internal micro-environment. In general, such sealed micro-environments should not be used without some method of stabilising and maintaining the RH. For materials that are particularly sensitive to, for example, acids or oxidants, then the use of suitable scavengers or active barrier layers may be appropriate. The use of internal indicator systems may also be of use, such as RH indicator strips, as these will highlight potential problems.

Assessment of Stability and Compatibility

The bulk composition of storage systems can generally be determined through labelling, information from the manufacturer or through chemical analysis (spectroscopy, etc.). Although this is of value in determining which materials may be appropriate, it should not be exclusively relied on as a guarantee of the long-term safety of objects housed therein. Polymers, for example, may contain plasticisers and other components in small quantities, but which are nevertheless sufficient to cause problems. Similarly a particular container may be compatible and suitable, but its integral seal may not be; or the foam used in a self-adhesive insulating strip may be acceptable, but not the adhesive itself.

Therefore it is necessary to test the systems and materials chosen to ensure that they will not present problems over the long term. This can be achieved using a set of simple tests which can be carried out with basic equipment. Although these analyses may appear to be time consuming and repetitive, they require little operator time and not only make certain that inappropriate storage solutions are not adopted, but if good records are kept they can allow suitable materials and containers to be more readily selected in future (and, of course, shared with other institutions facing similar problems).

The tests employed in this work are outlined in the experimental section, below.

Provision for Long-Term Monitoring and Assessment

It is recognised that collection items are unlikely to remain under the supervision of a single individual, and that anyone who subsequently becomes responsible for them will need to know how to look after them (such as monitoring to ensure that consumables are replaced when required). As specialist knowledge cannot be assumed, a simple advice sheet was devised, detailing, for example, characteristic colour changes of desiccants and scavengers that can be periodically checked to assess the quality of the storage conditions.

Experimental - Assessment of Stability and Compatibility

Short-Term Off-Gassing

The immediate off-gassing behaviour of the samples was assessed using Image Permanence Institute 'A-D Strips', originally intended to monitor the condition of photographic media, but also well suited to investigating the production of volatile acids by other materials. A sample of approximate weight 1g was placed in a boiling tube with a test strip and sealed with a stopper. This was left overnight and the colour of the strip then compared to a reference standard. This standard uses a colour change scale to indicate the degree of off-gassing, from '0' (no deterioration, hence no acidic off-gassing) to '3' (critical, hence significant off-gassing). Any indication of '1' or greater was considered unacceptable for use with collection items.

Oddy Testing (Long-Term Off Gassing)

The longer term off-gassing behaviour of the specimens was assessed using the Oddy test (Robinet & Thickett, 2003), a common method of determining the suitability of materials for conservation purposes. A specimen of approximate mass 1g was placed in a boiling tube, along with a vial containing 1ml water. Three clean metal tokens (copper (Cu), silver (Ag) and lead (Pb)) were suspended above the sample on a polyester thread. As a control, a further vial of water and set of tokens were placed in an empty tube. The tubes were sealed with a ground glass stopper which was secured in place with heat-shrink tubing. They were then placed in an oven held at 80°C, and left for 28 days, after which they were removed and the tokens examined for signs of tarnishing or corrosion - Cu tests for volatile oxidants, Pb for volatile acids and Ag for volatile sulphur compounds. (Other types of metal coupon can be used to test for different volatiles, as appropriate for the susceptibilities of different types of collection items.) Even moderate tarnishing, observed on any of the coupons, was considered to indicate that the material was unacceptable for use with collection items.

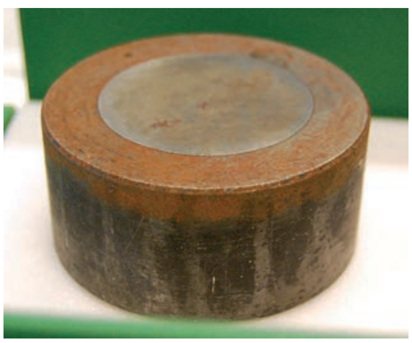
Surface pH Measurements

In addition to testing the potential of the materials to produce harmful off-gassing, surface pH was also measured, as some materials will become more acidic without releasing volatile acids, thus potentially damaging items in immediate contact. Both new specimens and those subjected to artificial aging through the Oddy test were assessed in this way. The measurement was carried out by moistening the surface of the specimen and applying a piece of universal indicator paper, then noting the resultant colour. Materials to be used in close proximity with collection items should not be significantly acidic or alkaline.

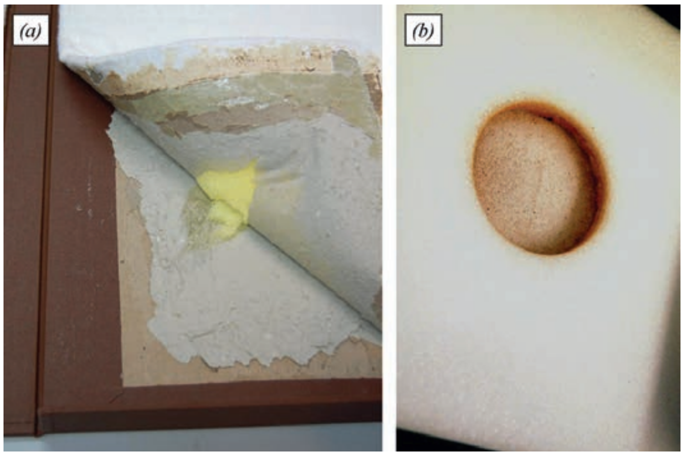
By combining the information from these individual experiments, it is possible to gain an understanding of the short- and long-term off-gassing and surface behaviour of the materials. From this it is possible to determine whether or not they are likely to be suitable for the storage of the items in question.

Case Study

The British Library holds a broad range of non-paper material, including items made completely or partially from metal, such as dies and plates in the Philatelic Collection composed of steel, copper or aluminium (Hanson et al., 2011). Many of these were discovered to be showing signs of rapid deterioration due to a rehousing programme approximately 12 years previously (Figure 1).



1. Corrosion found on a die plate.



2. Inappropriate housing materials: (a) board and adhesive; (b) foam.

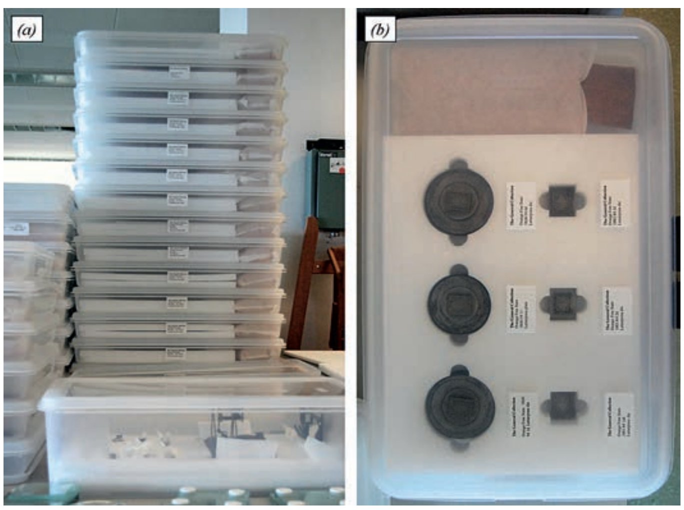
3. Fingerprint induced corrosion.

This programme involved transferring the dies, which exhibited no signs of corrosion or chemical deterioration, from the galvanised steel cans that originally housed them to drop-back boxes to protect them from physical damage. The new boxes were constructed from a range of boards, foams, adhesives and fabrics.

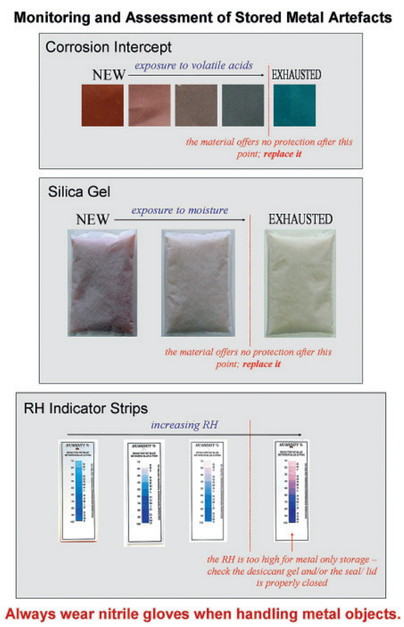
Once the damage had been discovered, analysis of these boxes showed them to be made of a variety of non-conservation grade materials, including acidic board, PVA and animal adhesives, polyurethane foams and fabrics containing bleach residues (Figures 2(a) and 2(b)). The volatile species released by these components generated a highly detrimental environment within the boxes. This was also exacerbated by a number of additional factors, including: the relatively high humidity of the Philatelic Collection (55-60 % RH) used to ensure the stability of the adhesives found on the verso of many of the stamps; the presence of cellulose acetate in neighbouring objects, generating ethanoic acid; and the use of boxes constructed from oak, which is known to release acidic gases, particularly at high or fluctuating humidities. Unsuitable handling practice was also in evidence due to the presence of fingerprints which had become etched into the metal surface through the corrosive action of sweat (Figure 3).

New storage solutions were sought using the procedure outlined above. The dies and plates were rehoused in food grade polyethylene containers of appropriate size, which were made airtight using an appropriate sealing strip (Tesa 'Draught Excluder, Omega Profile') (Figure 4). Internal structures and supports were constructed from Plastazote (polyethylene) foam, Tyvek (non-woven polypropylene fibre sheet) and Perspex (polymethylmethacrylate). Reusable silica gel bags were employed to ensure a low internal humidity; corrosion intercept strips were included to act as acid and pollution scavengers; RH indicator strips were placed in each container to allow the humidity to be monitored. Nitrile gloves were recommended for future handling, as latex rubber gloves contain sulphur compounds that can tarnish metals and cotton gloves can accumulate sweat, salts and residues of washing agents. Finally, an advice sheet was prepared to allow the colour changes in the silica gel, corrosion intercept and RH indicators to be readily interpreted by curators and conservators (Figure 5).

All of the metal items identified as being at risk have now been fully rehoused following this method. An initial biannual monitoring regime has been established to ensure the continued good condition of the items; after two years the assessment period will



4.(a) The new storage system in use; (b) an individual storage container - the transparent lids allow the housed items to be readily identified; the silica gel package and the corrosion intercept material can be seen in the box at the top of the image.



5. Advice sheet for long-term condition monitoring and assessment.

be reconsidered and adjusted according to the rate at which the consumables are expended. As other collections are brought forward by curators, damaged items or those perceived to be at risk of future deterioration will be similarly rehoused.

Conclusion

In conclusion it can be seen that by carrying out a systematic series of simple tests, it is possible to determine the suitability, or otherwise, of alternative and novel storage solutions. Importantly this may allow inexpensive and readily available materials to be used with confidence, in place of expensive specialist products, thus providing more suitable conditions for greater numbers of collection items and offering appropriate storage solutions to smaller collections and institutions with limited resources.

Acknowledgements

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Enfoque sistemático para la selección de soluciones no costosas de almacenamiento para conservación

El almacenamiento adecuado del los artefactos patrimoniales es vital para su supervivencia a largo plazo, mas la escogencia de las soluciones de almacenamiento idóneas no siempre es fácil debido al número de factores que deben considerarse y que potencialmente podrían estar en conflicto. Por ejemplo, el método de almacenamiento debe ser compatible tanto con los objetos propiamente dichos como con el entorno local; debe ofrecer soporte y protección adecuados; idealmente no debe ser costoso, y debe estar disponible rápidamente y ser fácil de usar. Después del descubrimiento de objetos en la colección de la Biblioteca Británica que mostraban signos iniciales de daño debido al almacenamiento inadecuado, se ideó un enfoque sistemático para seleccionar y evaluar soluciones potenciales de almacenamiento, como se muestra en este trabajo. Un objetivo particular era el uso de contenedores, materiales y regímenes de aplicación de pruebas que pueden obtenerse fácilmente y son asequibles, por lo que permiten un rápido realmacenamiento de todos los ítems que se han identificado en riesgo. Este enfoque también ubica dichos protocolos de pruebas y soluciones de almacenamiento dentro del alcance de las colecciones más pequeñas con presupuestos y recursos limitados.

Boxing the 'Big Huge': A Preventive Conservation Conundrum

by Annabelle F. Shrieve, Vauna Gross, Jeff Hunt, Tomomi Nakashima, and Randy Silverman,
University of Utah's Marriott Library, USA

Summary

Traditional housing options for extremely heavy books or acutely oversized three-dimensional library objects can prove inadequate. Cloth-covered drop-back boxes add undesirable weight to an already unwieldy package while corrugated paperboard phased boxes are insufficiently durable to provide long-term protection for their ungainly contents. Combining Peter Waters' principles of phased conservation (and their attendant benefits[1]) with advances in museum housing design for three-dimensional objects championed by Carolyn Rose and Amparo Torres,[2] and linking these ideas to testing use of corrugated polypropylene sheets (referred to as Coroplast throughout this article) conducted by the Canadian Conservation Institute (CCI),[3] staff at the University of Utah's Marriott Library developed a useful housing option for the library's overly-heavy ledger books and unconventionally-shaped, three-dimensional objects.

Advantages derived from using Coroplast as a material for housing gargantuan library material include its being chemically inert, lightweight yet rigid, and easily manipulated using simple hand tools. While prefabricated Coroplast boxes are currently available from commercial archival suppliers in standardized sizes for housing documents, maps, and textiles,[4] custom fitting Coroplast boxes have not been described in the library conservation literature. A model is defined herein for consideration as a conservation option.

Corrugated Polypropylene Sheets

The Coroplast corporation began operation in 1973 as a wholesale dealer of corrugated plastics based in Montreal that distributed product throughout Canada. The firm began manufacturing Coroplast in November, 1975 with the opening of its first plant in Granby, Quebec. Subsequently, a second manufacturing plant was opened in July, 1985 in Dallas, Texas, a third in Vanceburg, Kentucky in 2001, and acquisition of the plastic corrugated division of Spartech (Cornwall, Ontario) followed in 2005. The company's web site indicates that today Coroplast is "the leading manufacturer of corrugated plastic sheets for the sign and returnable packaging markets in North America."[5]

The material is known by various trade names: Coroplast®, Cor-X, and Hi-Core in North America; Correx in the United Kingdom; and Fluteboard and Corflute in Australia. According to the manufactures' literature, Coroplast® Archival grade is "a chemically inert, extremely durable polypropylene copolymer, extruded twinwall fluted plastic sheet free from additives such as coloring agents, antistatic and ultraviolet inhibitors." The company states it is "suitable for backing, mounting, and fabricating containment enclosures" and represents "A superior substrate for long-term use with no out-gassing. It is resistant to water, oils, and solvents at room temperatures." The only caveat mentioned in the product description is "Coroplast Archival is not recommended for any application in which it is exposed to high amounts of UV radiation, including all uses outdoors."[6]

Coroplast is a chemically inert polyolefin copolymer; the sheet has "a NIL pH factor."[7] It is structurally similar to corrugated cardboard, but instead of requiring an adhesive to join the outer membrane to the internal flutes or ribs, the twin-wall plastic sheeting is extruded as a single unit, eliminating delamination issues. The copolymer resin retains "the ability to be flexed an unlimited number of times without breaking" a characteristic the manufacture refers to as "a living hinge."[8]

Coroplast is commonly sold in large sheets (8 ft. x 4 ft. / 2.42 m x 1.21 m) in thicknesses ranging from 2 to 6 mm (0.07 in. to 0.23 in.). Both outer surfaces of the sheet are treated electrostatically with corona discharge to allow them to accept certain types of inks and adhesives. Scott Williams believes that "because it is made of solid polyolefin and many tests for extractables and odors in other applications such as food and pharmaceutical have shown low levels, by analogy, these products should be suitable for conservation."[9] Based on "spectroscopic analysis of a small number of degraded samples to determine the cause of their degradation," he cautions that Coroplast

1. Peter Waters. 1990. "Phased Preservation, a Philosophical Concept and Practical Approach to Preservation". In *Special Libraries* 81 (1) (Winter 1990): 35-43; and, 1993. "Phased Conservation Revisited". In *GCI Newsletter* 8.2. Los Angeles: Getty Conservation Institute.
http://www.gettymuseum.us/conservation/publications/newsletters/8_2/phasedconservation.html

2. Carolyn L. Rose and Amparo R. de Torres (eds.). 1995. *Storage of natural history collections*, Vol. 2. Washington, D.C.: Society for the Preservation of Natural History Collections.

3. Carl Schlichting. 1994. *Working with Polyethylene Foam and Fluted Plastic Sheet, Technical Bulletin #14*. Ottawa: Canada: Canadian Conservation Institute.

4. See for example, Hollanger Metal Edge, http://www.hollingermetaledge.com, search term "polypropylene box".

5. Information about Coroplast corporation was retrieved from the World Wide Web 16 March 2012: http://www.coroplast.com/about/index.htm. The company can be reached for more information in the U.S. and Canada at the following: http://www.coroplast.com/contact/index.htm
Dallas, Texas - Headquarters, 5001 Spring Valley Road, Suite 400 East, Dallas, TX 75244 USA tel. 800.717.0611 / Granby, Quebec - Canada Plant, 900 rue Cowie, Granby, Quebec J2J 1P2, tel: 800.361.5150.

6. Retrieved from the World Wide Web 16 March 2012: http://www.coroplast.com/catalog/coroplast-archival/

7. *Coroplast® Technical Bulletin* - CSS-011-93, retrieved from the World Wide Web 2 October 2011: http://www.coroplast.com/technicalinfo/prod-properties.htm

8. *Ibid*.

9. Email communication with Scott Williams, Senior Conservation Scientist (Chemist), Canadian Conservation Institute, 11 October 2011.

1. Vauna Gross posing next to her Coroplast box for a freestanding 7 ft. 8 in. (2.33 m) scale model of a NASA Saturn V Moon rocket complete with handles, padded earthquake bracing, and straps to secure the box to a structural column. Photo credit: Jeff Hunt and Randy Silverman.

2. Standard clamshell box design applied to a single sheet Coroplast box. Photo credit: Jeff Hunt.

should not be exposed to ultraviolet (UV) light sources such as fluorescent tubes or daylight, or to cleaning solutions, because UV radiation and certain oxidizing chemicals will cause the polymer to break down.[10]

While most archival products are purposely free of additives or colorants, Coroplast marketed as "archival" is clear and contains no UV filtration or oxidation stabilizers. This lack of pigmentation increases the plastic's susceptibility to photodegradation and as result will accelerate its deterioration. As there has been no evidence that UV filtration or oxidation stabilizers migrate or cause damage to objects, Williams recommends use of pigmented Coroplast. He believes black may be the most stable of the available options because it absorbs UV radiation and prevents photooxidation of the plastic.[11] Canadian Conservation Institute Senior Conservation Scientist (Chemist), Scott Williams, describes Coroplast as a material CCI has recommended for museum artifact housing and library exhibit supports since 1993.[12] He notes that some people have argued that "white is better because it is easier to see dirt and bugs, and it makes a room brighter,"[13] and concedes these may be legitimate conservation considerations, but the stability of the material inside the boxes is improved by using a color that blocks UV.

Custom Housing Oversized Objects

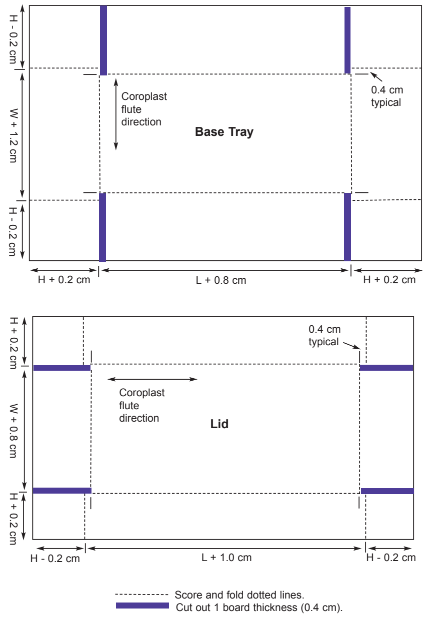
A venerable problem in library conservation is how to house objects so heavy they are unwieldy to lift or so large they do not conform to common dimensions of box-making materials (e.g., normal sheets of binder's board or bolts of book cloth). While the benefits of housing are universally acknowledged – protection in storage and transport from abrasion, light, dirt, changes in temperature and relative humidity, as well as a shield from potential water damage – some objects seem to defy normal boxing options. Examples of longstanding housing problem at the Marriott Library include several 30-pound (13.6 kg) manual typewriters originally belonging to American historian, novelist and Pulitzer Prize winner, Wallace Stegner, and a collection of unique, freestanding scale model rockets produced by the National Aeronautics and Space Administration (NASA) ranging in height from 8 in. (20.3 cm) to the towering 7 ft. 8 in. (2.33 m) Saturn V Moon rocket. (Fig. 1)

Given the fragility or sheer dead weight of these objects, an important consideration in fabricating their housing is how they are to be lifted from and returned to their boxes. For smaller objects, the box can be constructed from a single sheet of Coroplast relying on a standard clamshell design. (Fig. 2) With overlarge or very heavy pieces, the lid and the base can be formed from two separate Coroplast sheets. For these cumbersome objects, one option employs a Base Tray with rigid sidewalls permanently affixed with nylon snap rivets.[14] Another approach relies on re-sealable sidewalls that close magnetically. This is achieved by attaching magnetic strips to the Coroplast walls with double-sided tape[15] so the walls can be opened flat to provide unencumbered access to the object without having to lift it from the Base Tray.

10. *Ibid*.
11. Email communication with Scott Williams, Senior Conservation Scientist (Chemist), Canadian Conservation Institute, 6 May 2011.
12. See for example: Debra Daly Hartin. 1993. "Backing Boards for Paintings on Canvas." In *CCI Notes* 10/10. Retrieved from the World Wide Web 2 October 2011: http://www.cci-icc.gc.ca/crc/notes/html/10-10-eng.aspx; 1994. "Display Methods for Books." In *CCI Notes* 11/8. Retrieved from the World Wide Web 2 October 2011: http://www.cci-icc.gc.ca/crc/notes/html/11-8-eng.aspx ; and, Maria Esteva. 2001. "Corrugated Polypropylene: Properties and its Use in Conservation." In The Cochineal: The Forum for Student Work at the Kilgarlin Center for the Preservation of the Cultural Record. University of Texas at Austin. Retrieved from the World Wide Web 2 October 2011: http://www.ischool.utexas.edu/~cochinea/html-paper/m-esteva-01-polypropylene.html
13. Email communications with Scott Williams, Senior Conservation Scientist (Chemist), Canadian Conservation Institute 20 June 2011 and 16 March 2012.

14. Scott Williams has seen "boxes bonded with mechanical fasteners like rivets, Chicago screws, hot melt glue squeezed into channels, ribbons, and tabs; and adhesives like double sided pressure sensitive adhesive (PSA) tapes and glues, including hot melts on intact surfaces (not squeezed into channels). The only failures of load bearing bonds have been with the adhesive methods. Double-sided tapes and hot melts do not adhere well to low-surface energy surfaces such as polypropylene. Only adhesives recommended by the suppliers should be used. PSA tapes and adhesive should never be used for load-bearing bonds because the PSA generally has low shear strength and flows or creeps when stressed." Email communication with Scott Williams, Senior Conservation Scientist (Chemist), Canadian Conservation Institute, 11 October 2011.
15. Magnetic strips are available in 0.75- 1.5 in. (1.9-3.2 cm) widths and can be purchased without PSA attached to one side of the magnet. See, for example, the U.S. Adams Magnetic Products http://www.adamsmagnetic.com/. The recommended adhesive for attaching the magnet to the Coroplast walls is 3M™ Double Coated Tape 415, a 4.0 mil double coated polyester with acrylic adhesive 400 lined to a 4.0 mil 60 lb densified kraft paper liner. This tape is specified for archival applications in Library of Congress, Preservation Office, Polyester Film Encapsulation (Washington, D.C.: Library of Congress, 1980): 4.

3. Example of an oversized, early twentieth century post-bound ledger book prior to boxing. Photo credit: Brian Galyean.



4. Schematic drawing of a two-piece Coroplast box including scoring, folding and cutting instructions for the Base Tray and Lid. The Base Tray measurements plus (+) or minus (-) are added to or subtracted from the Length (L), Width (W) and Height (H) dimensions of the object. The Lid measurements are added to or subtracted from dimensions of the completed Base Tray. Drawing and Photo credit: Jeff Hunt.

Housing Oversized Books

A critical breakthrough realized with Coroplast in this material is strong enough to provide an answer for housing oversized and extremely heavy bound ledger books. Nineteenth and early twentieth century ledger books can exceed 41 in. (104 cm) in length and weigh in excess of 35 pounds (15.8 kg). (Fig. 3) Lacking a reasonable housing option to protect these important corporate personnel and financial records, the Marriott Library had, in fact for years, stored them unprotected on baked enamel shelving in an offsite storage facility.

Their unwieldy size and weight necessitated a design that provided both a durable transport unit to and from offsite storage and a way to minimize the need to lift the book from its box to gain access. The solution proved to be custom fitting, lightweight, two-part Coroplast boxes as described above, with the sidewalls joined with magnetic strips to encourage intermittent access.

Two-Piece Coroplast Box Construction

Requisite materials for housing oversized ledger books include 4 mm (0.15 in.) thick Coroplast, magnetic strips 0.75 in. (1.9 cm) wide, and nylon snap rivets. Necessary tools include: a standard 18 in. (0.46 m) steel ruler, 48 in. (1.21 m) beveled steel straight edge, scalpel, awl, bone folder, and heat gun with a 450° F (232 C) setting. Because Coroplast has sharp edges when cut, it is suggested the corners of each piece be shaped with a desktop corner rounder or scissors.

The two-piece Coroplast box is made according to the pattern on Figure 4. Measure the object's dimensions - length, width and height - and apply the values to the formula for the Base Tray. Mark off and score the lines for the box walls, cut out the corner material to accommodate folding, and fold and heat the walls along the scored lines. If desired, attach magnetic strips to the wall flaps to form a closing mechanism. (Fig. 5, p. 34) Similarly, determine the Lid dimensions by measuring the completed Base Tray and calculate the values using the Lid formula. (Fig. 6, p. 34) Secure the Lid walls with 7/16 in. (0.325 cm) nylon snap rivets.[16]

Considerations

Coroplast sheets 4 mm (0.15 in.) thick can be readily manipulated and the creases will hold their shape if the plastic is softened slightly by the heated airstream from a heat gun. Creasing and folding narrow sidewalls (less than 2.5 in. / 6 cm) is sufficiently difficult, however, that thinner Coroplast (0.07 in. / 2 mm thick) should be considered as an alternative because it proves to be more malleable.

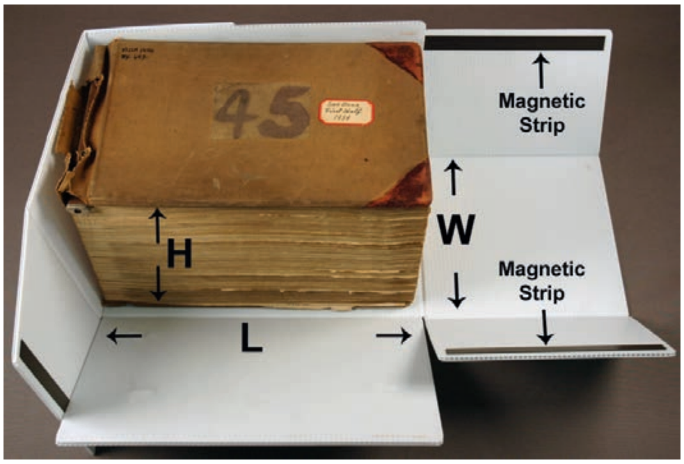
The Resources Subcommittee (Conservation Committee) of the Society for the Preservation of Natural History Collections of the Royal Ontario Museum notes that "channels in Coroplast may provide [a] habitat for insects."[17] Similar arguments could be made for any corrugated paperboard as well and this essential question should be addressed by monitoring for pests in collection storage.[18] Miranda Martin noted in a posting on the Conservation DistList that Coroplast boxes "melted onto their contents" during a controlled fire at a disaster response workshop in 2000 called "Burn Baby Burn."[19] Again, all plastics used for housing library collections, including polyester encapsulations, are equally likely to melt in a fire. Appropriate precautions – adequate smoke detectors and fire suppression systems to protect

16. Nylon Snap Rivets consist of a male and a female component joined with simple hand pressure. See for example in the U.S., KR TYPE 1 (0.325 in. / 0.825 cm) from King Richard Company: http://www.kingrichardco.com/SnapRivets.htm

17. Helen Coxon and Janet Waddington (compilers). Supplies and Materials for Museums Collections (v. Canada) (n.d.): 7. Retrieved from the World Wide Web 2 October 2011: http://www.docstoc.com/docs/41916913/Supplies-and-Materials-for-Museum-Collections-_v-Canada_

18. "Monitoring Insect Pests With Sticky Traps". In *National Park Service Conserv-O-Gram* Number 3/7 (August 1998). Retrieved from the World Wide Web 2 October 2011: http://www.nps.gov/museum/publications/conserveogram/03-07.pdf

19. Miranda Martin. 06-20-2000. "Large Archival Boxes." Message posted to Conservation DistList (06-20-2000). Retrieved from the World Wide Web 2 October 2011: http://cool.conservation-us.org/byform//mailing-lists/cdl/instances/2000/2000-06-29.dst



5. Clarification of Length (L), Width (W) and Height (H) in relation to an oversized ledger book. Magnetic closures allow the walls of the Base Tray to open completely to provide easy, unobstructed access. Photo credit: Jeff Hunt.

6. Completed two-piece Coroplast box for an oversized ledger book showing nylon snap rivets used to mechanically fasten the walls of the Lid. Photo credit: Jeff Hunt.

institutional collections are critical, but this observation should be weighed against Coroplast's ability to shed water which represents a relatively common problem in many storage facilities.

Finally, awareness of institutional relative humidity and airflow conditions should precede a decision to use plastics for housing collections. A direct observation following Hurricane Katrina was that plastic enclosures tended to restrict airflow to a greater degree than cellulose enclosures. Given the same water activity in two identical substrates the risk of mold growth may be greater inside a plastic enclosure than a paperboard one whether inside a tropical storage facility where environmental controls are lacking or because of summer equipment failure in a heating, ventilating and air conditioning (HVAC) system.[20]

Unlike molded Tupperware containers, the box design described above includes a loose fitting top and is made by folding sheets of Coroplast such that the four corner seams will admit water should the box become submerged. In the case of water ingress caused by a culinary pipe leak, engaged fire suppression system, or firemen's hoses, however, the box design will shed water far better than a paperboard box. Because the design requires that all four corner seams be slit to the base, it is possible that standing water on library shelving could wick into the box at the base. To remedy this risk, a one-layer Coroplast lift should be included in the bottom of each box. However, as with all disaster recoveries, any boxed material in the affected area would need to be removed from its protective enclosure and checked for dampness following the event.

20. See: Gary Frost and Randy Silverman. 2005. "Disaster Recovery in the Artifact Fields – Mississippi After Hurricane Katrina". In *International Preservation News* 37 (December): 35-47. http://www.ifla.org/VI/4/news/ipnn37.pdf

Benefits

Custom Coroplast boxes can be very cost efficient to produce once the practitioner moves beyond the labor intensive design process. With experience, a custom Coroplast box takes only about an hour to make (compared with four hours to build a comparable cloth-covered drop-back box). Given differences in hourly salaries and box sizes, the average cost to house the Marriott Library's collection of 360 ledger books averaged approximately $20.00 USD (15.0281 EUR) per box, including both labor and raw materials.

Scott Williams at CCI conservatively expects Coroplast boxes to have a shelf-life of 10 years. He made this prediction knowing, however, that CCI currently has boxes on its shelves that remain in excellent condition after 20 years or more.[21] As for longevity, it should be remembered that standard cloth and board drop-back boxes also break down with steady use, especially when they are oversized.

Conclusion

The benefits of adequate housing are reflected in the Heritage Health Index Report which states, "Storage is a critical component of preventive collections care because, with few exceptions, it is the environment in which collections are held much of the time."[22] For purposes of making custom-fitting boxes for overly large books and particularly heavy library objects, the authors found Coroplast, with its light-weight and water resistant properties, ease of manipulation, and affordability, offers a technical solution for material that may have previously remained un-housed for lack of a workable solution.

21. Personal telephone and email communication with Scott Williams CCI, May/June 2011.

22. Heritage Preservation. 2005. *A Public Trust at Risk: The Heritage Health Index Report on the State of America's Collections*. Chapter 6, "Collections Storage". Washington, D.C.: Heritage Preservation. Retrieved from the World Wide Web 2 October 2011: http://www.heritagepreservation.org/HHI/HHIchp6.pdf

Robots en los Archivos: Criterios de Uso y Rentabilidad

by José Antonio Sainz Varela, Director del Archivo Histórico Provincial de Álava, Eusko Jaurlaritza/Gobierno Vasco, Vitoria-Gasteiz, España

¿Ha llegado el futuro a los archivos?

La primera vez que contemplé las evoluciones de un robot transelevador moviéndose a lo largo de los pasillos de un enorme depósito de archivo quede gratamente asombrado. Obedeciendo a un ordenador, la máquina localizaba sin titubeos un contenedor colocado a más de diez metros sobre el suelo e indistinguible para mí de los cientos de contenedores iguales que lo rodeaban (fotografía 1). Tras extraerlo con delicadeza y sujetarlo, el transelevador lo transportó velozmente hasta depositarlo en un punto donde un operario abría el contenedor y revelaba su contenido: 24 cajas de archivo convencionales. Desde que se había realizado la petición del documento a través del programa informático que gestionaba el depósito, hasta su llegada a las manos del operario habían transcurrido menos de dos minutos.

Quizás muchos de los archiveros que hayamos contemplado las evoluciones de un transelevador en un depósito de archivo habremos experimentado inicialmente una gran satisfacción al ensoñar la ventaja que esta novedad tecnológica podría proporcionar a nuestro trabajo diario. Sin embargo, conviene ser cauto con las expectativas eufóricas. Aunque la robotización de los depósitos parece introducirse poco a poco en los archivos, todavía no sabemos con exactitud si en todos los casos donde se ha implantado ha producido los resultados esperados y si, por el contrario, ha generado algunos inconvenientes.

En realidad, aún no conocemos si la automatización de los depósitos podría ser un avance para nuestro trabajo de la misma magnitud que lo fueron en su momento las bases de datos informáticas o la reproducción digital. Por ello, conviene analizar las implicaciones técnicas, económicas y organizacionales que conlleva este fenómeno y determinar en qué afectaría a la calidad del servicio prestado a los usuarios.

Antecedentes: los depósitos de almacenamiento masivo

Hasta hace bien poco los mayores edificios de archivos públicos de Europa se diseñaban para almacenar, como máximo, de 40 a 45 kilómetros lineales de documentación en sus depósitos[1]. En estos años de predominio del llamado "modelo *Duchein*" lo usual era la concentración en una única sede de todos los servicios administrativos y culturales que puede prestar un archivo: recogida, almacenamiento, tratamiento, descripción, difusión,

1. El interior del depósito automatizado (o silo) del Archivo General de la Administración de Euskadi, en Vitoria-Gasteiz, obra de Iñaki Aspiazu Iza y LKS Ingeniería. Al fondo del pasillo se observa el robot transelevador.

etc. Con este nombre identificaremos este tipo archivo a lo largo del artículo[2]. Siguiendo este modelo, los depósitos –por lo general dotados con estanterías compactas– deben constituir del 50% al 70% del área útil del edificio. Es decir, si proyectásemos un edificio de archivo Duchein para albergar, por ejemplo, 50 km/l de documentación, probablemente necesitaríamos 10.000 m² de superficie útil total para múltiples oficinas, laboratorios y talleres de trabajo, áreas publicas de estudio y divulgación, etc. Se trataría, por tanto, de una infraestructura de gran tamaño y con complejos equipamientos, costosa de construir y aún más costosa de mantener. Esta es la razón que ha explicado la rareza de los grandes depósitos públicos hasta hoy.

Sin embargo, en estos últimos años ha tenido lugar un importante cambio arquitectónico en la concepción de los depósitos de archivo que ha hecho que se supere con creces la barrera de los 50 km/l de capacidad al tiempo que ha descendido sensiblemente su coste de edificación. La causa principal de este cambio ha sido la irrupción en el panorama archivístico internacional de las bien conocidas empresas privadas de custodia documental. Estas empresas, obligadas a maximizar beneficios, han adoptado la nave industrial como su modelo de depósito al ser mucho más barata de edificar y de mantener que un archivo Duchein.

1. Cierto es que existían dos excepciones que parecen confirmar esta regla: el Archivo General de la Administración (en Alcalá de Henares, España) y el Centre des Archives Contemporaines (Fontainebleau, Francia), ambos construidos en 1969 y con 160 kilómetros lineales de capacidad de almacenamiento cada uno. Estos han sido hasta hace apenas unos años los mayores depósitos europeos.

2. En 1966 el archivero francés Michel Duchein publicó, con el apoyo del Consejo Internacional de Archivos y de la UNESCO, un manual sobre la construcción de edificios de archivos. La obra tuvo una acogida muy favorable al ser la primera que, dirigida expresamente a los archiveros, reunía en un solo volumen todas las recomendaciones sobre la materia. Su influencia ha sido notable en la construcción de archivos durante todo el último cuarto del siglo XX hasta la actualidad De hecho, el canon de archivo propugnado por la obra ha pasado a conocerse, sobre todo en círculos francófonos, con el nombre de «modelo Duchein» (DUCHEIN 1985).

De esta forma, los depósitos tradicionales se han convertido en "depósitos de almacenamiento masivo" –podríamos llamarles así– situados por lo general en las afueras de las ciudades. Es materia de debate entre la comunidad profesional si deben considerarse verdaderos archivos o no ya que estas instalaciones, al no prestar servicio de atención al publico, no se dotan de ninguno de los habituales espacios de trabajo en los edificios de archivo salvo algún área para el tratamiento documental básico.

En lo que concierne a los sistemas de almacenaje, las empresas de custodia han logrado evolucionarlos en búsqueda siempre de la optimización de la capacidad de almacenamiento. Podemos clasificarlo en tres tipos:

a) Almacenaje fijo convencional

Es decir, estanterías fijas tradicionales. Es el sistema más barato de instalar y mantener de los tres. No posee ninguna servidumbre tecnológica aunque precisará de un número de operarios suficiente para atender manualmente las consultas de documentación que reciba el archivo.

El mayor inconveniente de este sistema es que, al emplear estanterías y pasillos fijos, necesita el doble de superficie, en comparación, con el sistema de almacenaje móvil compacto. A pesar de ello, es el sistema más utilizado por las empresas de custodia, que han pasado de gestionar simples naves repletas de estanterías convencionales a complejas estructuras prefabricadas de hasta tres entreplantas o mezzaninas, duplicando o triplicado la superficie útil de la nave y su capacidad de almacenamiento. Por precio, parece la opción más conveniente siempre que se disponga de superficie suficiente para construir anexos al depósito en caso de colmatación o las expectativas de crecimiento del fondo documental no sean altas. En todo caso no parece la opción más conveniente si poseemos un volumen de documentación superior a 50 km/l.

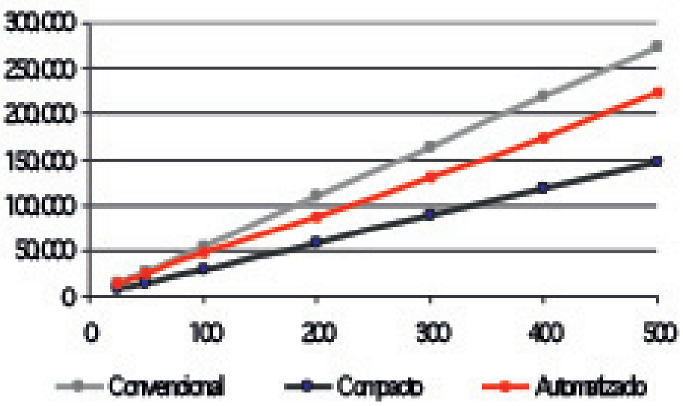


Gráfico 1. Relación entre el volumen de documentación almacenada (en el eje horizontal, en kilómetros lineales) y el volumen total (incluyendo altura) ocupado por un depósito masivo según se utilice uno de los tres sistemas de almacenaje (en el eje vertical, en metros cúbicos).

b) Almacenaje móvil compacto

Permite el máximo aprovechamiento del espacio disponible en el depósito gracias al uso de estanterías móviles que eliminan la necesidad de pasillos fijos y compactan el espacio entre estanterías. Su principal inconveniente es, debido a esta concentración, el elevado peso que deben soportar los forjados del edificio. Es el sistema más extendido en los archivos públicos de tipo Duchein, aunque la obligatoriedad de compartimentar el área de depósitos a 200 m^2 limita gran parte de su eficiencia con respecto al rendimiento que las estanterías móviles alcanzan en un depósito masivo.

El almacenaje compacto obtiene incluso mejores rendimientos que el almacenaje automatizado con robot transelevador. Su mayor limitación es su escasa posibilidad de crecimiento en altura ya que su elevado peso desaconseja desarrollos por encima de los 6 metros de altura.

c) Almacenaje automatizado (robots)

Es, con diferencia el sistema de almacenaje más caro, pudiendo alcanzar hasta un 400% de sobrecoste sobre el sistema convencional o el compacto. Como acabamos de ver, la principal ventaja del sistema automatizado de estanterías es, desde el punto de vista del aprovechamiento del espacio, su enorme capacidad de crecimiento en altura. Un transelevador puede operar sin problemas hasta los 20 metros de altura. Incluso podría adaptarse, en teoría, hasta los 40 metros. En este caso extremo se necesitaría el empleo de estanterías autoportantes, es decir, que éstas constituyen la estructura del edificio y sostienen no sólo la carga almacenada sino también los forjados, los muros exteriores y las cubiertas. Desde el punto de vista de la seguridad, la posible implantación de estanterías autoportantes es chocante, en cuanto tales construcciones fueron expresamente prohibidas en varios países europeos para el uso de archivos y bibliotecas por su alto riesgo de derrumbe en caso de incendio.

La principal desventaja del sistema automatizado –y no es poca– es la absoluta dependencia del buen funcionamiento del robot. Un fallo energético u otra avería del sistema detiene por completo la actividad del depósito.

Se ha realizado una comparación de rendimientos entre los tres sistemas. En el gráfico nº 1 se aprecia como los tres tipos de almacenamiento masivo siguen un mismo patrón de crecimiento progresivo en sus necesidades de volumen (metros cúbicos). El almacenamiento compacto (en negro) es el que ofrece mejores rendimientos. Esta ventaja comparativa es más evidente cuanto mayor sea el volumen de documentación a almacenar. Hasta los 100 km/l, por ejemplo, el aprovechamiento del volumen es similar en el sistema convencional (en gris) y el automatizado (en rojo).

El gráfico nº 2 analiza únicamente el área utilizada por los depósitos según el tipo de sistema de almacenaje empleado. Aquí se aprecia como la posibilidad de elevar significativamente la altura del almacenamiento automatizado (en rojo) le coloca en ventaja competitiva sobre los otros dos. Particularmente sobre el almacenamiento compacto (en negro) a partir de los 200 km/l.

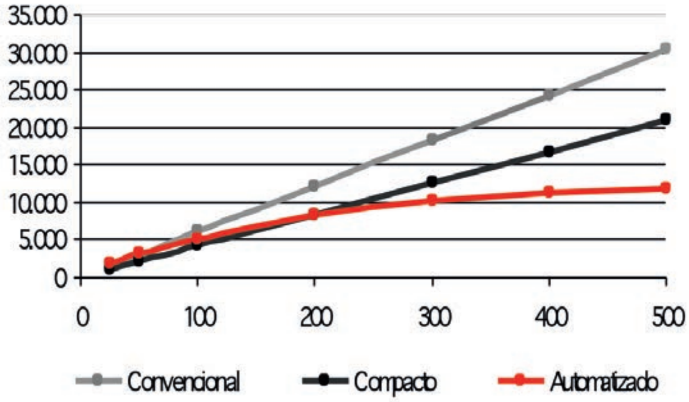


Gráfico 2. Relación entre el volumen de documentación almacenada (en el eje horizontal, en kilómetros lineales) y el área ocupada por un depósito masivo según se utilice uno de los tres sistemas de almacenaje (en el eje vertical, en metros cuadrados).

Robots en funcionamiento

Como hemos visto arriba, la principal diferencia entre un archivo y un depósito masivo de almacenamiento es que éste último se dedica exclusivamente a la custodia de documentos. Es decir, apenas cuenta con algunos espacios para trabajos de organización archivística. No tienen, por tanto, el resto de servicios de un archivo tradicional, en particular el de atención al público.

Aparentemente se trataría, por tanto, de un modelo no exportable al ámbito público, ya que ni siquiera dispone de una sala de consulta. ¿O tal vez si que lo sea? Veamos tres ejemplos españoles recientes de depósitos masivos aplicados al ámbito público y privado y con ciertas diferencias en su funcionamiento.

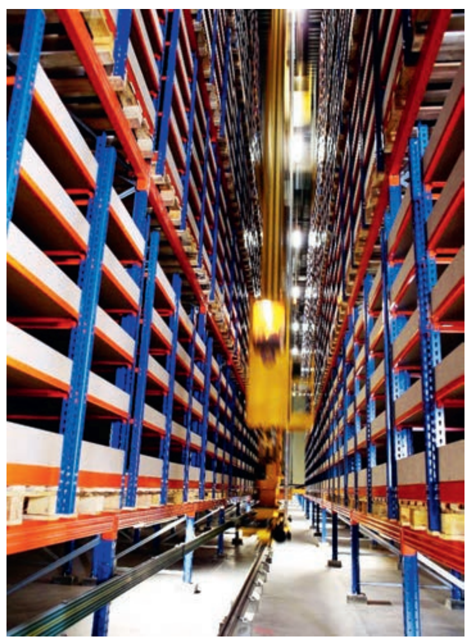
a) Centro de Almacenamiento de Documentación Administrativa

El Centro de Almacenamiento de Documentación Administrativa (CADA), en Las Rozas (Madrid), es un edificio gestionado por SEGIPSA, la empresa pública dependiente del Ministerio de Hacienda de España que administra el patrimonio inmobiliario del Estado. Presta servicios tanto a la administración publica como a clientes privados a los que aplica determinadas tarifas por conservar y servir su documentación, como si de una empresa de custodia se tratase, si bien sus precios son más bajos que la media del mercado (Martín, 2008). Se trata del caso español más importante de depósito de almacenamiento masivo automatizado. Este edificio, con un coste de 13 millones de euros e inaugurado en 2006, posee un "silo" –el nombre atribuido al depósito– de 10.779 m^2 de superficie y una capacidad para 400 km/l de documentación. Por tanto cada metro lineal precisa de 0,03 metros cuadrados. Se trata de un rendimiento mucho mayor que el que permiten los depósitos del Archivo General de la Administración (AGA), en Alcalá de Henares (Madrid). El AGA es un archivo de tipo Duchein que puede almacenar 160 km/l en un área útil de depósitos de 28.524 m^2, es decir cada metro lineal precisa de 0,18 metros cuadrados: cinco veces de superficie que la que precisa el CADA.

La unidad de instalación utilizada es el almacenamiento en palés-estanterías con seis estantes de carga y medidas de 0,80 m. de frente por 1,20 m. de fondo por 2,00 m. de alto con una capacidad de hasta 144 cajas de archivo definitivo. Los palés-estanterías son colocados por el robot transelevador en una estantería-rack distribuida en doce pasillos de cinco niveles de carga de doble profundidad. Su almacenamiento es aleatorio y es decidido por el programa informático que gestiona los huecos en función de su "rotación". Este es un concepto importado directamente de las empresas de custodia. De manera similar a como se hace en los almacenes de mercancías, se sustituye la instalación secuencial consecutiva de los contenedores –ya sean cajas o palés– por la aleatoria. Esta aleatoriedad viene dada por la mayor o menor frecuencia de consulta –o de "rotación", como se le conoce técnicamente– de estos contenedores. El programa informático controla el inventario topográfico de los depósitos, indica cuales son los documentos más consultados y propone su colocación en la zona más accesible del depósito para el robot. El CADA clasifica sus contenedores en cuatro grupos según su nivel de rotación: "A" para aquellos con más de 18 movimientos anuales; "B", de 3 a 17 movimientos anuales; "C", de 1 a 2 movimientos anuales y "D": para aquellos sin ningún movimiento desde su entrada en el silo.

El manejo de los palés-estanterías se realiza con dos transelevadores automáticos con una capacidad de carga de una tonelada y una capacidad de elevación de doce metros de altura (fotografía 2). Cada transelevador es capaz de extraer del depósito un total de once palés-estanterías a la hora, lo que aporta un rendimiento total de veintidós palés a la hora. En todo caso, el diseño de CADA no busca obtener grandes rendimientos en el servicio de préstamo, en cuanto su diseño esta dirigido a conservar documentación con un ratio medio bajo de consulta. Por ello, la elección de instalar un robot esta orientada al manejo de un altísimo volumen de documentos con el mínimo personal.

El CADA se encuentra a 24 km. del centro de Madrid y dispone de un servicio continuo de transporte de documentos hasta la capital.



2. Uno de los dos transelevadores del CADA recorriendo sus pasillos de 13,30 metros de alto.

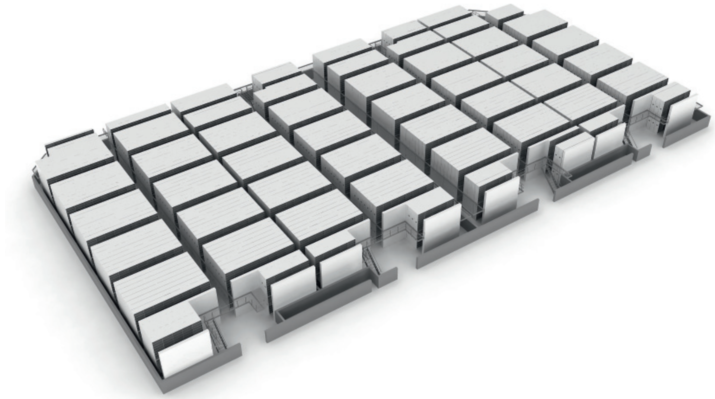


Gráfico 3. Infografía representando el interior del Archivo General de Unicaja (AGU). Utilizando un sistema de compacto de estanterías móviles modelo EUN, se logra almacenar 100 km/l en un volumen mínimo: 30.000 m^3.

b) Archivo General de Unicaja

En los últimos veinte años, muchas administraciones públicas y grandes empresas han externalizado la gestión de sus archivos porque carecían de medios para conservar la documentación que producían o bien porque consideraban la gestión del archivo como una función auxiliar dentro de sus objetivos de negocio. La actual crisis económica les está impulsando a recuperar sus documentos y construir sus propias infraestructuras para conservarlos.

Este es el caso de la caja de ahorros Unicaja, cuyo Archivo General (AGU) se inauguró en 2010 en Humilladero (Málaga). Con un coste de ejecución de 11,5 millones de euros posee una superficie de depósitos de 4.232 m^2 capaces de almacenar 100 km/l de documentación en estanterías compactas, lo que implica que emplea 0,04 metros cuadrados por cada metro lineal (fotografía 3). En comparación, el Archivo Histórico Provincial de Álava (AHPA), un archivo de tipo Duchein inaugurado en Vitoria-Gasteiz (Álava) en 2005, posee 2.678 m2 de depósitos con 22 km/l de estanterías compactas, es decir utiliza 0,12 metros cuadrados por cada metro lineal, el triple que en el caso del AGU.

Unicaja optó por la instalación de estanterías compacta en lugar de automatizadas ante al elevado precio que suponía la robotización –cuatro veces más– del depósito. Al no estar automatizado, y recibir una media de 200 peticiones de consulta diariamente el AGU emplea de 8 a 10 operarios para localizar manualmente la documentación –el denominado "picking" manual. Para mejorar los tiempos de búsqueda se ha implantado otro método de trabajo traspasado de la gestión automatizada de almacenes: cuando los operarios reciben las peticiones, un programa informático de control topográfico del fondo documental, les indica la ruta óptima que deben recorrer hasta los estantes concretos de los cuales recoger las cajas requeridas en el menor tiempo posible.

A diferencia del CADA, el AGU, situado a 75 km de Málaga, no transporta la documentación hasta los solicitantes que se reparten por todo el territorio español, sino que les envían copias digitalizadas certificadas. Por ello el AGU cuenta con unos amplios talleres de digitalización.

c) Archivo General de la Administración de Euskadi

El Archivo General de la Administración de Euskadi (AGE) fue inaugurado en 2010 en Vitoria-Gasteiz (Álava) como archivo intermedio del Gobierno de la Comunidad Autónoma del País Vasco. Se trata de un edificio con una superficie útil de 5.460 m^2, diseñado como un depósito masivo automatizado para almacenar 50 km/l de documentación[3]. Al igual que en el CADA, un robot recorre su pasillos guiado por un programa informático que optimiza recorridos y gestiona la colocación topográfica de los contenedores.

Su caso es interesante de analizar por el alto coste de construcción del edificio y de la instalación del transelevador: 16 millones de euros en total. Ya hemos visto que el importe del metro lineal en un depósito de almacenamiento masivo es mucho menor que en un archivo de tipo Duchein. Sin embargo, en el caso del AGE, el metro lineal ha costado lo mismo que el caso, por ejemplo, del Archivo Histórico Provincial de Álava[4]. Esto se debe a que en realidad el AGE es un curioso híbrido de archivo de concentración de tipo Duchein y depósito de almacenamiento masivo automatizado. Si la instalación de un transelevador ha obligado a diseñar la estructura principal del edificio –su silo robotizado– , alrededor de él se han anexado los lugares de trabajo usuales para archiveros incluyendo talleres de digitalización e incluso una sala de consulta. Igualmente, para lograr altos estándares de seguridad antiincendios se han dividido los pasillos del silo en sectores que pueden aislarse del resto mediante compuertas automáticas. Además, la unidad de instalación es un contenedor de acero para la máxima protección de los documentos frente al fuego y les preserva del polvo del polvo ambiental (fotografía nº 3). Por último se logrado la estabilidad termohigrométrica del depósito gracias a la inercia térmica que le proporciona su "doble piel": el depósito se construye a modo de cofre de hormigón separado de las cubiertas y muros exteriores por una cámara intermedia de circulación.

Todo estas prestaciones extraordinarias para un depósito de almacenamiento masivo, ha elevado considerablemente su coste final si lo comparamos con el caso del CADA –400 km/l por 14 millones de euros– o del AGU –100 km/l por 11,5 millones de euros.

Criterios de uso y rentabilidad

Llegados a este punto debemos plantearnos las preguntas importantes: ¿Es la automatización de depósitos una mejora evidente para un servicio de Archivo? ¿Cómo podemos saber cuándo conviene automatizar un depósito?

Si se valora seriamente la instalación de un transelevador en un depósito de almacenamiento masivo debemos conocer previamente cuales serán las posibilidades de crecimiento del edificio

3. Puede descargarse un modelo 3D en la dirección http://sketchup.google.com/3dwarehouse/details?mid=100599e280a0320f3b8e06f36cc8428b&ct=3dbl&hl=es. La Memoria de Ejecución del proyecto puede descargarse en www.euskadi.net [junio 2012].
4. El AHPAL costó 7 millones de euros en 2005. Su ficha técnica puede consultarse en línea:
http://www.mcu.es/GIEC/es/PrincipalesProyectosyObras/ObrasConcluidas/Archivos/alava.html

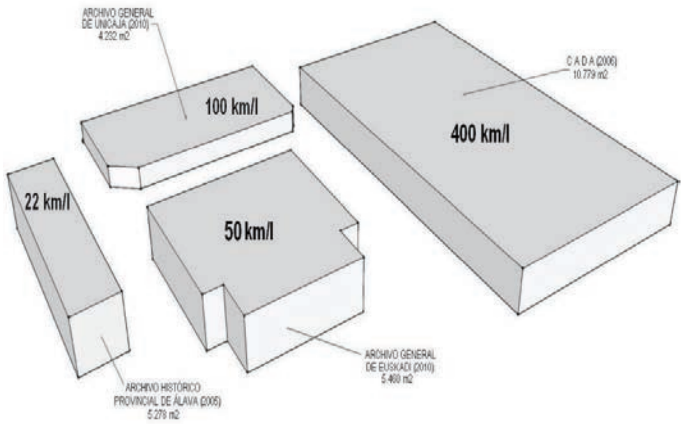


Gráfico 4. Comparación visual de los volúmenes de un archivo de tipo Duchein, el Archivo Histórico Provincial de Álava, a la izquierda, y tres depósitos de almacenamiento masivos, dos de ellos automatizados. Se indica la superficie útil de cada uno de ellos.

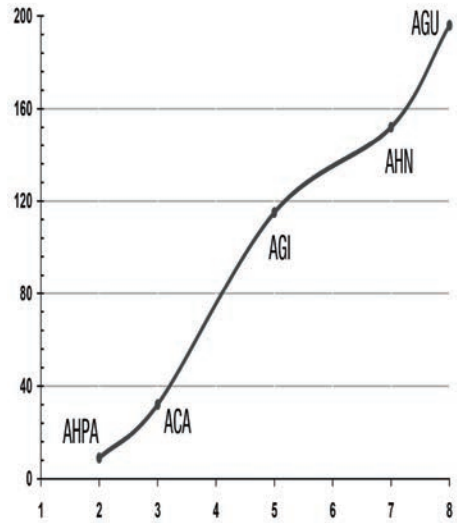


Gráfico 5. Relación operarios/consultas. Además de los archivos señalados en el texto, se incluye al Archivo Histórico Provincial de Álava-AHPA (Vitoria-Gasteiz) y al Archivo de la Corona de Aragón-ACA (Barcelona).

en superficie y altura. Si se dispone de espacio y de personal suficiente, el almacenamiento convencional de estanterías fijas podría ser la opción más rentable; si lo que queremos es, ante todo, aprovechar el volumen disponible, el sistema óptimo es el de estanterías compactas móviles.

El ahorro de espacio sólo puede servirnos de argumento para decidir la automatización de un depósito si contamos con un volumen muy grande de documentación almacenada –a partir de 50 km/l– o su frecuencia de consulta es muy alta. La opción del robot gana enteros si, además, podemos desarrollar la altura del depósito por encima de los quince metros. Al contrario, debemos descartar del todo su implantación si no podremos desarrollar esta altura por encima de los 6 metros. En cualquier caso, la automatización es el sistema de almacenaje más caro de instalar en un depósito masivo: como mínimo triplica el precio del sistema compacto más sofisticado. A título orientativo diremos que la automatización de un depósito puede costar en torno a los cuatro millones de euros.

Por el contrario, el mantenimiento de un transelevador es más barato que el de una plantilla numerosa de operarios. El mantenimiento anual de un transelevador puede suponer aproximadamente entre 25.000 y 35.000 euros al año[5]. El consumo eléctrico del transelevador no es especialmente significativo y, en todo caso, no supera los costes que puede generar la climatización artificial de los depósitos.

En el gráfico nº 5 se compara el número de consultas diarias (eje vertical) con el numero de operarios asignados a la búsqueda y transporte de documentación –picking– desde los depósitos hasta la sala de consulta (eje horizontal) de varios archivos históricos españoles. El Archivo Histórico Nacional (AHN), en Madrid, atiende una media de 152 peticiones presenciales de consulta en sala de lectura con una plantilla de 7 operarios; el Archivo General de Indias (AGI), en Sevilla, atiende 115 peticiones con 5 operarios; Por último, se ha incluido al Archivo General de Unicaja (AGU), en Humilladero, que consigue atender una media de 200 peticiones al día con 8 operarios. La gráfica muestra la relación de proporcionalidad que existe entre el número de consultas y la necesidad de plantilla: puede concluirse que un operario es capaz de atender entre 20 y 24 peticiones de consulta diarias[6].

Teniendo en cuenta que un transelevador debe manejarse por uno dos operarios parece claro no debe automatizarse un depósito si las peticiones que recibe pueden atenderse con el mismo número de empleados, es decir, si recibe menos de 40 peticiones al día.

Los costes de estos servicios son variables. Dos de los archivos más consultados de España, el Archivo General de Indias –28.640 consultas al año– y el Archivo Histórico Nacional –38.043 consultas al año– han externalizado con empresas el servicio de operarios que realizan la recogida de la documentación en depósitos y su traslado a la sala de lectura: el coste de estos contratos anuales asciende a 145.000 y 115.000 euros respectivamente. Se tratan de precios superiores al coste de mantenimiento anual de un transelevador, aunque aún muy lejos del coste de inversión inicial que supone la automatización de un depósito.

Quizás el criterio fundamental a la hora de decidir la automatización de un depósito sea el número de peticiones de consulta de documentación. La calidad del servicio prestado al usuario exige velocidad de respuesta y un transelevador puede darla. El robot del CADA, por ejemplo, es capaz de completar once ciclos por hora –el recorrido de ida y vuelta que realiza para transportar el contenedor solicitado. El del AGE alcanza los 60 ciclos por hora. Ambos pueden obtener aun mayores rendimientos si se programa su software para ello.

A la hora de optar por un sistema de almacenaje automatizado es fundamental escoger adecuadamente el volumen del contenedor de instalación. Cuanto menor sea esta unidad, mayor será la efectividad de los ciclos que realice el robot. Por ejemplo, en la unidad de instalación del CADA, el palé-estantería (fotografía 3), pueden instalarse 120 cajas de archivo normalizadas. Esto significa que cada vez que se solicita una caja concreta, en

5. Se trata de cifras referida al mercado español.

6. Los datos han sido extraídos de la Estadística oficial de los Archivos Estatales del Ministerio de Cultura correspondiente a 2010; en línea: http://www.mcu.es/archivos/docs/Novedades/Estadisticaarchivos2010.pdf [Junio 201].

3. Las unidades de instalación del AGE (arriba) y del CADA (abajo): un cofre de acero y un palé-estantería.

ese ciclo el robot transporta 1 caja correcta y 119 incorrectas. EL AGE, por su parte almacena 24 cajas en cada unidad de instalación lo cual implica que sólo se reciben 23 innecesarias cuando se solicita una concreta.

¿Es la automatización el medio definitivo para cumplir el sueño utópico de todo archivero: poder localizar cualquier documento o información cuando se busque? Lamentablemente, no. El robot no es más que una herramienta que se limita a transportar desde el depósito hasta nosotros un contenedor, una unidad de instalación en cuyo interior se encuentra la información que deseamos. Aunque dispongamos del transelevador más rápido del mercado, nunca podremos tener acceso a esa información si no conocemos previamente que existe o no sabemos en que documentos podría localizarse: nuestra dependencia de un buen sistema de información es absoluta (Martín Suquía, 2001). Quizás la automatización haya tenido éxito en el ámbito bibliotecario gracias precisamente a que todas las unidades bibliográficas almacenadas, los libros, están catalogados uno a uno y no hay margen de error en las búsquedas. Es decir, que la recuperación de información es exacta.

En cambio, la realidad bien conocida por los archiveros es que hay muchos fondos documentales cuyo nivel descriptivo es mínimo. En estos casos, cuando se desconoce el número del expediente concreto, la búsqueda de la información obliga al contacto directo con la documentación en los depósitos para practicar revisiones correlativas o secuenciales en las cajas. Por tanto, no deberá automatizarse un depósito si el nivel descriptivo de los fondos que almacena es deficiente, si no es posible identificar, como mínimo, las series documentales que contiene.

Conclusiones

Un robot transelevador que recorre velozmente los pasillos de un depósito documental es, en esencia, una herramienta más del trabajo diario que se realiza en un archivo. Al igual que el resto de recursos humanos, técnicos, económicos o procedimentales de que disponemos, su instalación no es un fin en si mismo (Sainz Varela, 2011). Al contrario, se trata únicamente de un medio para lograr el principal objetivo de nuestro trabajo: preservar los documentos y su contenido y recuperarlos cuando sea preciso.

La única razón válida, por tanto, para decidir la automatización de un depósito de archivo es mejorar la eficiencia del servicio prestado a los usuarios y la reducción de su coste. Es decir, realizar el trabajo más rápidamente, con menor índice de error y por menos dinero que el personal humano.

Existen voces que se alzan duramente contra la automatización de los depósitos de archivo; que consideran injustificado el enorme gasto de inversión que supone la instalación de un robot porque, en su opinión, un archivo nunca podrá generar tantas rotaciones de documentos que amorticen los ciclos que es capaz de realizar un transelevador. Los robots del AGE, por ejemplo, pueden atender perfectamente mil peticiones de documentos al día. Pero ¿es realista esperar que ese Archivo alcance tanto movimiento alguna vez? En cambio, por debajo de 200 consultas diarias puede considerarse que su inversión ha sido deficitaria. Y actualmente sólo recibe 40 consultas al día…

Otras voces defienden la instalación de transelevadores no para obtener velocidad sino para lograr el manejo de inmensos depósitos documentales, de cientos de kilómetros de documentos como es el caso del CADA, En estos casos, el sistema de almacenaje automatizado se diseña suponiéndole una baja rotación a los fondos.

Se trata de opiniones divergentes que debemos escuchar con atención para mejorar nuestros criterios ante la robotización. Resulta indudable que la automatización tan sólo debería implantarse en depósitos masivos y se justifica mejor cuanto mayor sea el volumen de la documentación almacenada. Sin embargo, cualquier instalación debe estar precedida por un estudio económico que indique el sistema de almacenaje más rentable en cada ocasión. Es muy conveniente que la comunidad archivística comparta sus experiencias al respecto para mejorar nuestros argumentos frente a un fenómeno cuyas implicaciones y utilidades futuras aún no son evidentes.

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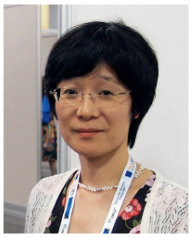
News from IFLA-PAC Regional Center for Asia: Naoko Kobayashi appointed as PAC Director



Naoko Kobayashi, a Senior Librarian of the Acquisitions and Bibliography Department, National Diet Library, was appointed Director of the IFLA-PAC Regional Center for Asia, successor to Ms. Noriko Nakamura, on April 1, 2012.

She started her library career in 1986 at the National Diet Library. In the first year, she was involved in translating "Principles for the preservation and conservation of library materials" into Japanese, which was originally published by the IFLA Conservation Section in 1986. This was her first experience in preservation and conservation.

She has moved to various divisions in the library every three or four years. At the same time, she was a part time member of the Preservation Planning Office, planned symposiums for promotion of preservation and conservation, and was involved in yearly pH Surveys on newly-acquired materials, etc., from 1988 to 2004.

From 2004, she was Assistant Director of the Preservation Division, working with 12 conservators, several librarians, and the Director of IFLA-PAC Regional Center for Asia. She was interested in disaster planning and carried out a practice session of salvage of water-damaged materials for the first time in the NDL with her colleagues. She also served as a Standing Committee member of the IFLA Preservation and Conservation Section (2005-2009). She was one of the moderators of the P&C preconference of the IFLA 2006 "Preservation and Conservation in Asia", the first satellite meeting that Ms Christiane Baryla attended as PAC International Director.

Just before her current position, she served as Director of the Children's Services Division, International Library of Children's Literature, Branch Library of the NDL for four years. She has been a Standing Committee member of the IFLA Section of Libraries for Children and Young Adults since 2009. As the 2013 IFLA-PAC satellite meeting will be held with the CYA Section, her experience will be helpful in connecting the two groups, PAC and CYA.

New publication: *Aligning National Approaches to Digital Preservation*

We are pleased to announce the publication of *Aligning National Approaches to Digital Preservation*, edited by Nancy Y. McGovern (Volume Editor) and Katherine Skinner (Series Editor). Educopia Institute: 2012.
On May 23-25 2011, more than 125 delegates from more than 20 countries gathered in Tallinn, Estonia, for the "Aligning National Approaches to Digital Preservation" conference. At the National Library of Estonia, this group explored how to create and sustain international collaborations to support the preservation of our collective digital cultural memory. Organized and hosted by the Educopia Institute, the National Library of Estonia, the US Library of Congress, the University of North Texas, and Auburn University, this gathering established a strong foundation for future collaborative efforts in digital preservation.

Readers may access *Aligning National Approaches to Digital Preservation* as a freely downloadable pdf and/or as a print publication for purchase. Please visit http://educopia.org/publications/ANADP to download or order the book.

IFLA Newspaper Section Preconference, 7-9 August 2012, Mikkeli, Finland: on-line proceedings

The Newspaper Section preconference on "The Electronic Re-evolution - News Media in the Digital Age" was held in Mikkeli, Finland, on August 7-9. It was organized by the Centre for Preservation and Digitization of the National library of Finland, with the support of the Preservation and Conservation Core Activity (PAC), following the Paris conference on the same topic.
Christiane Baryla, as PAC Director, attended this event, which was a real success thanks to the Mikkeli Centre for Preservation staff.
The speakers' presentations are now available on the conference website:
http://www.ifla2012mikkeli.com/materials

The National Library's Centre for Preservation and Digitisation, founded in 1990 and directed by Majlis Bremer-Laamanen, is a leading expert in its field in Finland. It conserves and protects the National Library's unique and irreplaceable collections and produces surrogate copies by microfilming and digitisation.
The Centre of Mikkeli uses microfilming to produce surrogate copies of items that are in poor condition or in danger of destruction, as Newspapers collections.

Announcements

Training: "Understanding and preserving audio collections", 22-24 October 2012, British Library, London, UK

From the end of the 19th century, sound recordings have documented some of the most significant events in culture, science and history. Today, custodians of audio collections are faced with the challenge of maintaining access to our priceless audio heritage, and the urgent need to digitally preserve recordings held on fragile and obsolete formats. Understanding and Preserving Audio Collections will guide you through collection management and preservation strategies, with an emphasis on digitisation for preservation and access. The course has been developed for anyone with audio collections, whether managing or simply using audio materials. It is led by members of the British Library Sound & Vision department.
The main areas covered are:
- Analogue audio carriers and technology
- Digital audio theory
- Collection level overviews
- Working with audio files
- Archival principles for audio material

Cost: £435 + VAT (including lunches and refreshments)
Programme and registration details: http://www.bl.uk/blpac/audio.html

ICOMOS ICORP International Symposium: "Cultural Heritage Protection in Times of Risks: Challenges and Opportunities", 15-17 November 2012, Istanbul, Turkey

In recent years natural and human induced hazards have increasingly turned into disasters of increasing frequency and intensity. These disasters pose threats to prominent cultural and natural heritage sites of the world. The aim of this symposium is to contribute towards reducing slow as well as catastrophic risks in short and long term, by sharing various case studies carried out or planned for mitigating their impacts and developing solutions with the cooperation of professionals working in this area.
The symposium aims to adopt a comprehensive approach that includes all kinds of risks of natural and human origin that threaten/might threaten cultural heritage. Various themes and topics would include all kinds of direct or indirect risks, including wars and local conflicts, large-scale projects that fail to recognize cultural heritage, effects of

mass tourism, legislations and policies and their consequences which sometimes do not consider cultural heritage at all or in limited way are within the scope of the symposium.

Symposium topics

In the field of cultural heritage:

- Mitigating risks from natural disasters
- Mitigating risks from human induced disasters
- Reducing risks from urbanization pressure
- Policies and legislations for risk reduction
- Reducing risks from tourism pressure
- Responding and recovering from disasters
- Role of media in disaster risk management
- Awareness and training for disaster risk reduction

Organizers: Yildiz Technical University, Istanbul; ICORP (International Committee on Risk Preparedness)

More information about the symposium registration: www.har.yildiz.edu.tr

Contact:
Yildiz Teknik Üniversitesi, Mimarlik Fakültesi Restorasyon Anabilim Dalı D-205,
34349 Besiktas/Istanbul
Tel: +90 (212) 3832630-32
E-mail: har@yildiz.edu.tr

"Migrating heritage: networks and collaborations across European museums, libraries and public cultural institutions", 3-4 December 2012, University of Glasgow, UK

The conference is organised by HoA - School of Culture and Creative Arts, University of Glasgow as part of EC-funded FP7 project European Museums in an Age of Migrations (MeLA, http://www.mela-project.eu/).

Topics

- Case studies on museums, libraries and public cultural institutions collaborating for European integration
- Operative approaches to multiculturalism, interculturalism, transculturalism in public cultural institutions
- National and transnational collaboration models: partnerships, cooperation, coordination
- European cultural policies, migration and mobility
- Identity, memory and heritage in European museums, libraries and public cultural institutions
- Studies on European narratives and cultural points of divergence and commonality
- Contested European cultural and scientific heritages in a post-migratory world
- Visitor experiences in collaborative projects involving European museums, libraries and public cultural institutions
- Archiving, preservation and exhibition technologies in relation to migration and mobility
- Politics of migrating objects, including repatriation
- Cross border tourism, customs and border policies, including souvenirs and museum replicas

Registration

Conference attendance is free, but advanced online registration is required. Registration will open in September 2012.

Anticipated audience

- Scholars and PhD students in museum studies, cultural studies, social anthropology, sociology of organisations, library and information science, cultural policies, social sciences, human-computer interaction and related areas
- Practitioners from museums, libraries, public institutions
- Decision-makers and policy makers
- Users of cultural institutions and representatives of migrant communities

Contact:
Contact chairs at
mela2012conference@glasgow.ac.uk
Website: http://wp3.mela-project.eu/wp/pages/research-field-03-international-conference

"CULTURAL HERITAGE on line - Trusted Digital Repositories & Trusted Professionals" Conference, 11-12 December 2012, Florence, Italy

Fondazione Rinascimento Digitale is delighted to announce the 3rd edition of the "CULTURAL HERITAGE on line - Trusted Digital Repositories & Trusted Professionals" Conference at the Historical Complex of Santa Apollonia. This year the focus is on competences and skills necessary to manage trusted digital repositories.

In particular the following topics will be investigated:
- how to preserve digital contents in a trusted digital repository
- how to understand cultural heritage and digital humanities specific requirements
- long-term preservation policies for trust and sustainability
- the role of standards and the importance of cooperation among user communities
- user needs for training and re-skilling of professionals in cultural institutions
- a focus on the Italian policy framework for the cultural and scientific heritage

Registration

Standard fees (before November, 30): € 150 (including gala dinner)
Registrations will close on December 7, 2012.

Contact:
info@rinascimento-digitale.it
http://www.rinascimento-digitale.it/conference2012

AIC-PMG & ICOM-CC PMWG Photographs Conservation Joint Meeting, 11-15 February 2013, Wellington, New Zealand

The American Institute for Conservation - Photographic Materials Group (AIC-PMG) and the International Council of Museums - Conservation Committee Photographic Materials Working Group (ICOM-CC PMWG) are pleased to announce their Joint Meeting in Wellington, New Zealand, February 2013. It will be the first time either group has met in the southern hemisphere. The meeting will include three days of conference and two days for workshops and tours. Additional information about related events and activities will follow.

The combined meeting brings together the world's practitioners in the field of photographs conservation. Presentations will deal with all aspects of photographic preservation and conservation, including:

- examination
- analysis
- documentation
- preservation and treatment of historic to contemporary materials
- storage
- exhibition
- digitisation
- ethics
- sustainable practices
- challenges of current economic restraints
- environmental disasters or threats

More information at: http://www.icom-cc.org/52/event/?id=172

Organizers: ICOM-CC PMWG & AIC-PMG
Endorsements: National Library of New Zealand, Archives New Zealand, Te Papa, The New Zealand Film Archive, ICOM-NZ

Contact:
Mark Strange, Convenor
2013 Photographs Conservation Joint Meeting
National Library of NZ PO Box 1467
Wellington 6140
Mark.Strange@dia.govt.nz
Tel: + 64 4 474 3149
Fax: + 64 4 474 3035

Report

The General Conference of Congress of Southeast Asian Librarians (CONSAL), 28-31 May 2012, Bali, Indonesia By IFLA-PAC Regional Center for Asia

The 15th CONSAL Meeting and General Conference was held at the Discovery Kartika Plaza Hotel, Bali, Indonesia, from 28-31 May, 2012, hosted by the National Library of Indonesia in cooperation with the Indonesian Library Association. Founded in 1970, CONSAL holds a conference every three years to promote cooperation in the field of librarianship, bibliography, and related activities. Its member countries are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. More than 750 people from the member countries and other neighboring countries came to the conference.

The theme of the 15th conference was "National Heritage: Preservation and Dissemination". The afternoon of the first day was devoted to the 20th Conference of Directors of National Libraries in Asia and Oceania under the same theme. Mr. Hidetoshi Kanebako, Director General of the Acquisitions and Bibliography Department of the National Diet Library, presented a special report on "The Great East Japan Earthquake and Libraries", referring to activities supporting reconstruction, for example, "the Cultural Property Rescue Programme", a national programme to salvage damaged cultural heritage. He also introduced another national project to build a digital archive of the Great Earthquake which aimed at long-term preservation of records and memories of the disaster.

On the second day, six papers were presented in the plenary sessions by speakers from the Netherlands, USA, India, Australia, Indonesia and Japan. Most of them mainly dealt with digital topics, but Mr. Akio Yasue, former Deputy Librarian of the National Diet Library, talked about disaster planning. His presentation "Disaster Planning: a Must for Libraries", clearly conveyed the basic philosophy and measures for disaster preparedness and a lot of pictures of library and archives collections damaged by the Great East Japan Earthquake and their rescue projects caught the attention of the audience.

The third day was dedicated to parallel sessions. The topics were "Resource sharing & networking", "Preservation and conservation in the library", "Managing digital library and digital publications", "National library as the center of national heritage", "Community libraries in information literacy and the role of libraries for enhancing reading habit" and "Implementation of legal deposit act and library education in empowering human resources". There were about 50 presentations in total and various cultural events were held in the evenings. It was a successful conference filled with energy and friendship.

The full program is online at:
http://www.consalxv.org/programme/

PAC CORE ACTIVITY

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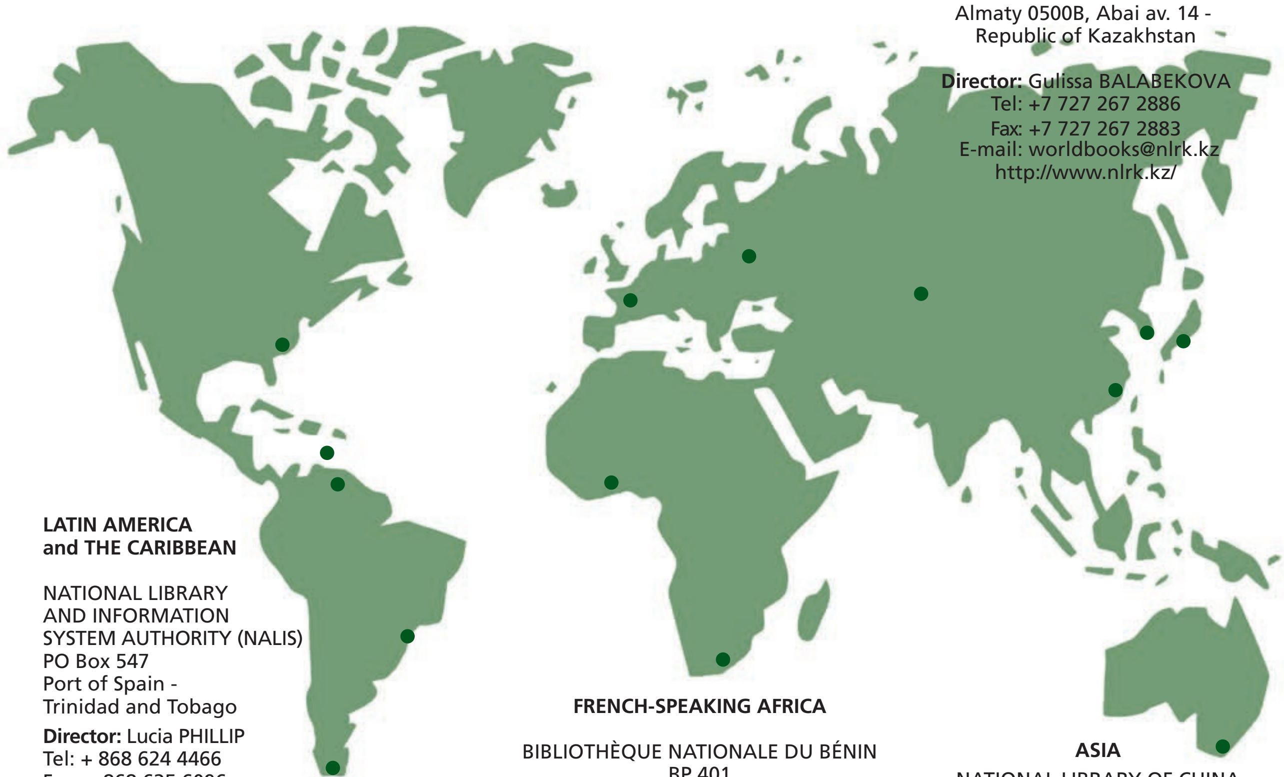

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E-mail: jspinelli@bn.br
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E-mail: pacasia@ndl.go.jp
www.ndl.go.jp/

NATIONAL LIBRARY
OF KOREA
KRILI/Preservation office
Banpo-Ro 664, Seocho-gu
Seoul 137-702 - Korea

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E-mail: leegw@mail.nl.go.kr