The changing face of storage at the British Library

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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 150million 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.

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.

Fig.1 The British Library, St Pancras, London

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 strong-rooms, 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.

Fig.2 Building 31, The British Library, Boston Spa, Yorkshire

Fig2A. High density, Building 31

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 (know 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.

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 kilometre 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.

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

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^{o}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.

Fig.4 Cold Storage Suite for BL microfilm masters

Fig.5A Films are re-canned and bar-coded

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]
- 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 1000ft cans and more than 120,000 x 100ft 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 BS545 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.

[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

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 institution 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 PD 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.

Thank you for your attention.