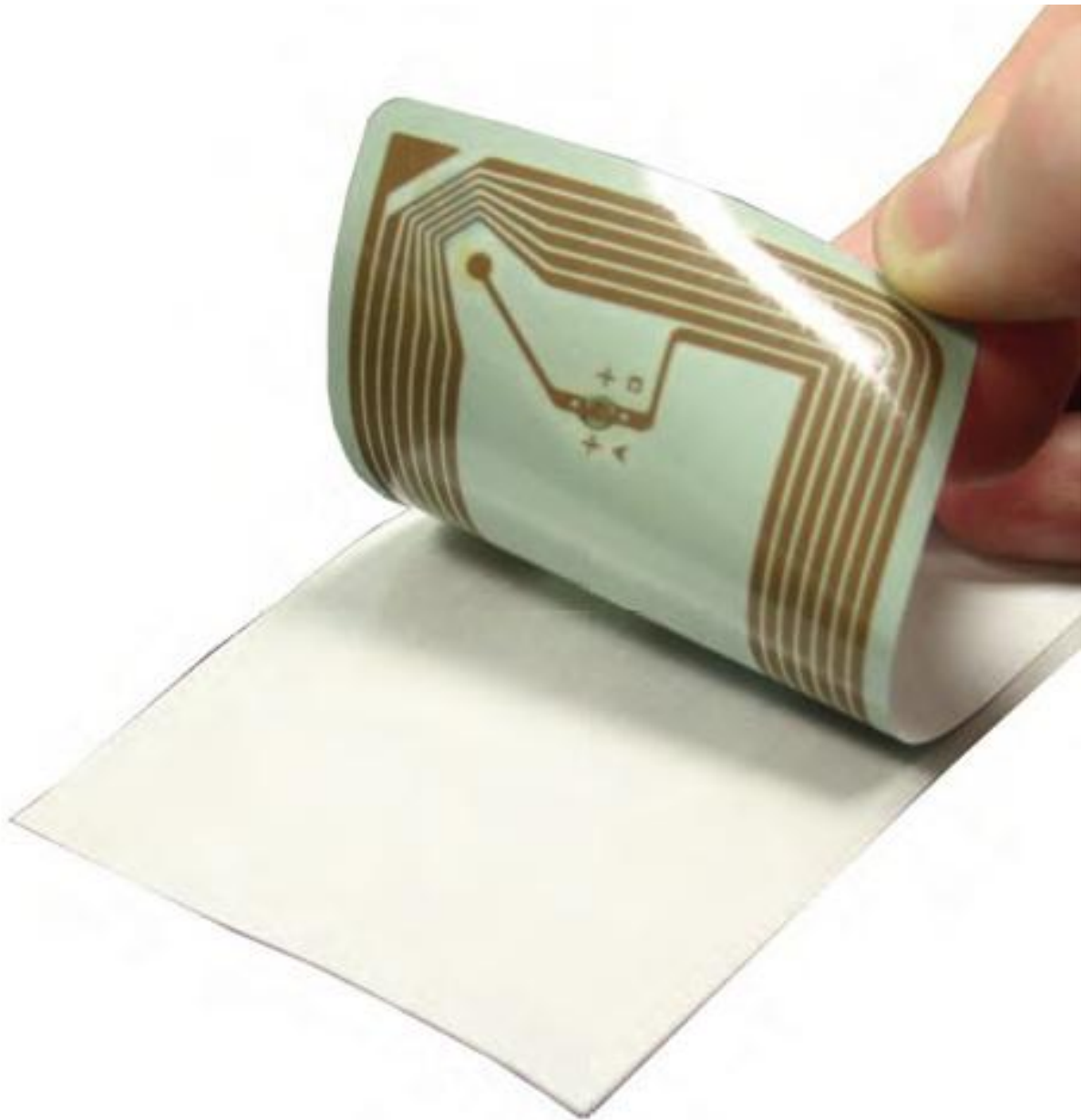


# Reviewing Machine Readable Labelling Systems for Collections Management and Access

Final report by Julian Tomlin



14 March 2008

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## 1. Introduction and Brief

### 1.1 Purpose

The London Museums Hub has commissioned this review of the use of machine-readable labelling systems across the heritage sector to evaluate the benefits of this technology both as a collections management tool and as a means of providing user access to collections information. The study focuses on the use of machine-readable technologies eg Radio Frequency Identification (RFID) and bar coding as methods to control object movements, update locations, enhance security and facilitate access to information associated with an object or collection of objects.

### 1.2 Brief

The following is extracted from the Invitation to Tender document.

#### Key objectives

- Research the methodology and practicality of RFID tagging or bar coding objects from different collection types as evidenced by the experience of current user museums and similar institutions. The consultant should make a minimum of four site visits to organisations currently using machine readable labelling systems.
- Assess the suitability of RFID and bar coding technologies in the management of cross disciplinary museum collections which by their diverse nature have proved challenging to tagging systems in the past
- Review the capabilities of the technology in the management of object movement and its capacity to enable immediate location recognition and retrieval to ensure real time collection management information
- Review the potential of RFID and bar coding systems to provide enhanced access to multiple layers of information for users of stored or densely displayed collections
- Report on the levels and layers of documentation and object information security offered, if any by RFID systems
- Provide a case study library or database of current usage

#### Interim Report

The interim report must be structured around the following areas:

- An examination of the past, present and potential uses and users of machine readable labelling systems by museums, libraries and archives as collections management tools.
- An evidence based report on the benefits and drawbacks of using these systems, including an evaluation of the longevity of the technology and its ability to interface with SPECTRUM compliant collections management databases

- A case study library or database

### **1.3 Presentation of interim findings to the Hub**

The consultant presented their interim findings to the Hub Partner Museum representatives and the project manager at a meeting on 27 February 2008. This provided an opportunity for the hub representatives to give feedback on the work to date, review progress and help to inform the next phase of work and final report.

### **1.4 Final report**

The final report is intended to build upon the interim findings, incorporate any feedback from the hub partner representatives and include:

- The time and resource implications for the Hub Partner Museums in the potential implementation of a system.
- An impact assessment on general collections management procedures likely as the result of implementation of a system.  
The above can be found in section 4 – ‘Potential for implementation in the partner museums’
- A glossary of technical terminology used.  
This can be found in the section 2 -‘Technological Overview’.

## **2. Technological Overview**

The report primarily deals with 1D, 2D barcodes and RFID tags.

### **2.1 1D Barcodes**

1D barcodes are traditional linear or one-dimensional. They have been used since the 1960s and are ubiquitous in the retail sector. The information they carry is represented through different codes, often for different business purposes. For instance, the UPC (Universal Product Code) and EAN (European Article Code) can be found on general goods. The codes can also have suffixes eg EAN 13, for general goods, EAN 8 for confectionary. Codes can carry different data elements eg EAN 13 has three – the country of origin, the manufacturer, the product number, followed by a check digit.

There are also codes for representing alphanumeric strings. Most commonly used in inventory systems are Code 39 and Code 128 (which breaks down into 128, 128A, 128B, 128C). Code 39 can only contain upper-case characters, numbers and a limited range of special characters. Code 128 barcodes are smaller and more flexible being capable of representing all 128 characters in the ASCII character set (including accented characters). Code 128B can contain lower case characters and a wider range of special characters. Code 128C allows for an increased number range 00-99, whereas 128A only allows 0-9. (Fig 1)

### **2.2 2D barcodes**

2D or two-dimensional barcodes share the ability to use the range of characters in Code 128, but were developed to carry more data, up to 2400 (Western) characters. They appear as a grid of squares or dots but are less widely used than 1D barcodes. There are over 20 different types; open standard types are DM (Data Matrix) and QR (Quick Response) codes. DM codes can contain 2335 alphanumeric characters while the rather larger QR codes have the ability to capture Japanese Kana and Kanji characters. This is perhaps why QR codes have become the standard for mobile phones in Japan. (Fig 2)

In Japan 2D codes can be found on posters and other promotional material. The user takes their mobile phone and, using its built-in camera and a reader application, photographs the code. The software interprets the code eg as a web address, and the user is prompted to open that page. It can also direct the phone to send an SMS message, for instance to request information. (Fig 3)

### **2.3 RFID tags**

Radio Frequency Identification or RFID tags are sometimes referred to as a replacement for barcodes as they have a number of advantages.

- no line of sight is needed to be read
- can be read up to several metres away, even in poor visibility
- not affected by dirt and moisture
- larger amounts of data can be stored
- not restricted by the need to use certain codes
- carry a unique number that can be locked

The tags normally have two parts, an integrated circuit for storing the data, and an antenna for receiving and transmitting. The size is primarily dictated by the size of the antenna. (Fig 4)

Once relatively expensive, ready-numbered tags are available in bulk for less than 5 US cents. This is still much more than barcodes which can be purchased for less than 0.5 cents. Typical prices for robust tags in modest quantities are much higher, eg 30 pence. (Fig 5)

There are three types of tag, passive, active and semi-passive. Passive tags need no power source; instead the scanner powers the tag. Active and semi-passive tags require a power source, usually a battery. This may last up to ten years.

With passive tags, a signal is sent to the tag, and the tag responds. With no need for a battery, the passive tags can be extremely small, although their size is limited by the need for an antenna. Tags as small as 0.05 x 0.05mm have been developed and have been referred to as 'RFID powder' as they are so small.

Active tags are usually more reliable as the signal that they produce is at a higher power level.

With semi-passive tags the battery powers the signal but doesn't broadcast it.

The antennae operate at different frequencies:

- LF – used for animal tracking
- HF – used in libraries, and smart cards eg the Oyster card issued by Transport for London
- UHF – used for supply chain activities
- Microwave – used for toll roads

#### **2.4 Reading barcodes and RFID tags**

Barcodes are read by using special readers. These link to software which captures the data and usually relays this to a computer. The readers may be hand-held or in a fixed position. In a typical museum application where a curator is moving an object, the curator will use the reader to scan an object's barcode. This will link to a unique number for the object such as an accession number. The new location will be scanned, perhaps along with the curator's name and the date will be added by the computer system. This data may be stored on the device for later uploading or may directly update the database of the collections management system.

With RFID tags, the process is similar but objects need only be brought into the range of the reader to be logged. An object in packaging may be detected with the tag inside. As well as using hand-held readers, static readers may be placed in doorways, such as of a store. Movements would then be automatically logged; if the mover is carrying an identity card with an RFID tag the mover could also be recorded.

Barcodes need to be seen by the operator who receives a confirmation such as a beep when read. In contrast RFID tags are read automatically, and there is no way of the operator knowing how many tags should have registered. There is therefore a

risk that some tags are omitted from the process, or tags not intended for reading have been read accidentally.

Certain mobile phones, with the appropriate software, can act as a reader. If the phone doesn't come with the software, it can in some cases be downloaded. Mobiles that can read RFID tags are rare and reading tags is a heavy drain on the battery. Support for 2D codes is becoming more common on higher-end mobiles. Also, since one of the uses of 2D codes is to link to the Internet, high-speed access is desirable.

Near Field Technology (NFC) is a high frequency wireless technology used in mobile devices and offering increasing opportunities for interaction. A trial with Transport for London extended the ability of such mobile devices to act as a substitute for the Oyster card, providing a poster on the Underground which once read could alert the traveller to transport options from that location.

## **2.5 Attachment**

Barcodes are normally printed onto labels which are then attached directly to containers, boxes, cupboards and shelves.

Since they are rarely attached directly to objects, an alternative is to attach the barcode label to a tag which is then tied to the object. Tags can be acid-free, made from polypropylene, and high-density polyethylene such as Tyvek®. Both are resistant to moisture, certain chemicals and tearing.

Conservation suppliers provide acid-free foil-backed labels, which prevents adhesive bleeding through to the printed surface and improves adhesion to irregularly shaped surfaces. Acid-free cord or twine is used with identity tags.

Label protectors are available to protect printed labels from abrasion and other damage.

Conservation by Design supply labels which use Poly Butyl Acrylate Resin adhesive which can be removed with industrial spirit. There are issues with adhesive attaching

to certain surfaces. Apart from general dirt and dust, alcohol such as that found in specimen jars presents a particular problem.

### **3 Review**

#### **3.1 Introduction**

Barcode technology is ubiquitous through its use in identifying consumer goods. Indeed we are invited to use in self-service points in some shops and libraries. RFID tags, having a less obvious physical manifestation, are less familiar.

Libraries have wholeheartedly embraced barcodes and have, more recently, been implementing RFID in some major projects. New libraries such as the Jubilee library in Brighton have made significant investments to use RFID for their complete stock, and install the necessary infrastructure, whereas established libraries such as the John Rylands University Library in Manchester use RFID only for short-terms.

The situation in museums is somewhat similar. Where there have been major refurbishments, often part-funded by the Heritage Lottery Fund, barcodes have often been used in essential evacuations of museum objects. However, there are far fewer examples of introducing barcodes for ongoing collections management.

One of the earliest adopters of barcode technology in the heritage sector was English Heritage in the late 1980s where it was used in a series of trials covering a major part of the archaeology/architectural stonework collection. However, the IT infrastructure was not ready, there was no link to the collections management software and there were problems with attaching barcodes to objects.

In this and other cases the introduction of barcodes and RFID tags has not been followed by consistent usage. Another example is the Gemeentemuseum, The Hague where the collections were identified with barcodes in 1996-7 during renovation but were not subsequently used. When staff revisited the situation ten years later, they found that the barcodes were never integrated with their CMS and some barcode labels had fallen off. They made a decision to abandon the old identification and start the process of introducing the newer RFID tags. (see Case Study 4)

### **3.2 Barcodes and RFID Tags**

#### 1D codes

The most commonly used machine-readable technology used in the heritage sector is 1D or conventional barcodes. This is due to the fact that it is more established, cheap to use, and with fewer technical issues than RFID.

#### 2D codes

There was no evidence found of 2D codes being used in museums for collections management or visitor access. In response a pilot of 2D codes was arranged at Manchester Art Gallery in March 2008. Codes for six objects were placed the 'Revealing Histories' display. Visitors were invited to use their own mobile phones to retrieve and submit further information about the objects on show. 2D codes are an emerging technology which has the potential for low-cost linking to web resources. (see Case Study 7)

#### RFID

RFID tags are a newer technology but unlike barcodes there is not the range of standards for numbering. They are considerably more expensive, around 50 US cents each, whereas barcodes being capable of being printed on standard office printers are usually cheaper. The cheapest tags are supplied pre-numbered. Relatively large amounts of data can be written to the tags. At The Children's Museum in Indianapolis tags carry a description of the object and its location. (see Case Study 2)

Line of sight is not required and this is particularly attractive in certain applications such as security. The National Gallery, London, along with other museums, uses Aspects Arts™ supplied by ISIS which communicates with active RFID tags hidden in frames. The credit card size tags transmit a signal every 15 seconds for a minimum of five years. ISIS Aspects Arts™ software monitors the locations of the tags, triggering an alarm when objects are moved without authorisation. (Fig 7). This system uses a range of high frequencies, rather than the now more common 2.4ghz frequency used in 802.11 standard wireless networks.

RFID tags can be used with gates or gantries, at the doorways of stores for example, where objects and staff carrying an identity tag can be automatically detected and logged when they pass through. Because of costs this doesn't appear to have been implemented in museums.

### **3.3 Readers, Writers and Standard Software**

As well as barcodes and RFID tags, these machine-readable technologies require other hardware, such readers and, for RFID, optionally writers. Specialist software to generate barcode labels and software can be open-source or paid-for. Alternatively, this function can be incorporated into custom programs and collections management systems. Barcodes can be printed on standard office printers, although some museums such as Museum Victoria, Melbourne buy them commercially which they find more economical and of a higher standard.

The reader software on hand-held devices generally derives from usage in commercial inventory management which in some cases, such as the ARTiFACT TRAC system used at The Children's Museum, has been adapted for specific use in museums. (see Case Study 2). Common functions are recording movements, through reading an object id and location id; and identifying contents at a location. Data may be stored on the local device, for later uploading to a server, or may be communicated directly to the server via a wired or wireless network as in MVWISE, (see Case Study 6).

At a basic level, a barcode scanner is just an alternative to a keyboard in entering data and can be used in a variety of applications. The Ashmolean Museum of Art, Oxford wrote a program which uses Microsoft Excel to record the decant of their collections. (see Case Study 1)

### **3.4 Collections Management Systems**

Integration with a collections management system is less common. MVWISE is an example of a system running on PDAs, designed for use with a sophisticated CMS, KE EMu. It uses a web interface to manage collections information held on the central KE EMu database. (see Case Study 6)

Adlib and Helicon Conservation Services have been developing 'Adlib Museum Tracker', drawing on their experience in a number of museums in the Netherlands. This promises to provide live linking to Adlib databases from Windows CE based PDAs, and can make use of barcode and RFID tags. The system can also write to RFID tags. (see Case Study 4)

RFID tags have the capacity to hold fairly significant amounts of data in layers, so they can carry the basic information on the object, as well as locations information. However, many museums prefer to just use the RFID tag and use a central database to retrieve current information from the server. This ensures that data is consistent.

It is a straightforward matter to add a barcode ID as a field in a CMS. To record objects the standard approach is to allocate a separate number for the barcode, rather than using the object's accession number. One museum uses accession numbers but others have found this problematic where an object has multiple parts which are handled separately, or where there is a group of objects with a single accession number.

Some users of MODES for Windows (The Great North Museum and Norfolk) have found issues in interfacing with scanner output with older versions of MODES for Windows. (See Case Studies 5 and 9).

### **3.5 Attaching to objects**

There are clear issues about attaching barcodes or RFID tags to objects. Actual attachment to objects should be avoided for a variety of reasons, the size of the barcode or tag has an impact on the visibility of the object\*; and there is also potential for damage to the object through adhesives.

\* This may change with RFID tags becoming extremely small with trials of tags 0.4mm x 0.4mm, without an antenna.

At the Walker Art Center, Minneapolis the RFID tags supplied by Washi-Wrap have been placed in Japanese paper sleeves, then attached to mounts or frames with wheat starch adhesive. (see Case Study 2)

For some objects, acid-free labels or tags are attached to objects using acid-free string.

Even using barcodes with the smaller Code 128 symbology, labels can be visually intrusive. The Petrie Museum had intended to display barcodes next to objects on display to allow staff and visitors to retrieve information on individual objects.

However they found their use in dense displays was not acceptable and currently group the labels at the end of shelves. There is potential to use RFID tags under labels. (see Case Study 10)

### **3.6 Visitor Access and Learning**

RFID tags are used in visitor interaction in a variety of ways. Legoland, Denmark offers wristbands, with embedded RFID tags, to child visitors enabling staff to track lost children. The Tech Museum, San Jose provide a wristband which can be used with RFID readers set amongst the displays to record objects of interest. Information on these objects is then made available in a specially created individual webpage which can be viewed after the visit. (Fig 8)

At the Hunt Museum, Limerick, 'keycards' and some objects on display carry an RFID tag. Visitors wanting to know more bring it close to a reader and trigger an interactive display.

The Children's Museum is introducing RFID tags for collections management and plan to use them to provide information for visitors. (see Case Study 2)

The Fitzwilliam Museum, Cambridge worked with Hypertag Ltd to provide hand-held guides to the collection. 20 objects from the collection are highlighted with special labels which carry infra-red tags. A drawback of infra-red is like barcodes it requires line of sight. A new system to be supplied by Antenna Audio will not rely on tags. (see Case Study 3)

The PDAs used at Cambridge can use various networking technologies, Bluetooth, 801n wireless as well as infra-red. Mobile phone increasingly have such facilities and some have the ability to read RFID tags and 2D codes.

Wireless networks may be used to make the hand-held devices location aware. They may detect which room the visitor is in and trigger appropriate content for that space..

2D codes offer the promise of providing inexpensive links to resources, such as a website address (perhaps in alternative languages) through a visible link, but only for visitors with mobile phones equipped with the necessary reader software. However, the cost of accessing the Internet may be a barrier to users on more restrictive tariffs. (see Case Study 7)

### **3.7 Benefits and Drawbacks**

When used for large-scale collection moves, the use of machine-readable technologies have been highly successful and cost effective.

The technologies are not yet in widespread use in museums. Even where installed some installations still require the specialist input of senior collections managers, are only used by project teams who managed the original moves, and are not embraced by other parts of the museum not affected by the move. This is despite clear benefits of their use.

The greatest success may be found where suitable systems, training and support, and procedures are in place eg at Museum Victoria. (see Case Study 6)

The costs of implementation can be high, particularly with RFID although the main costs are in applying the barcodes and tags to objects, which involves careful handling. At the Ashmolean over 20 staff were employed to undertake 'The Decant', an almost industrial process. However, the additional time taken for barcoding in the evacuation of objects was almost certainly saved in subsequent operations. (See Case Study 1)

As well as problems with tags adhering to surfaces and dropping off, some concerns have been expressed about the life cycle of RFID tags. These have been quoted as ten years, with 100,000 activations. Clearly, the last measurement gives greater confidence in their longevity. For those institutions using tags, replacing faulty tags has become an uncommon but straightforward matter.

## **4 Potential for implementation in the Partner Museums**

### **4.1 The partner museums in the London Museum Hub are:**

The Geffrye Museum

The Horniman Museum

London Transport Museum

The Museum of London

### **4.2 Assessing implementation - questionnaire**

A questionnaire was drawn up to assess what opportunities there were for introducing machine-readable systems, and help identify the shape and scale of possible implementation.

The museums were asked the following questions:

#### Collections

1. What is the overall number of objects in the collection?

This number should reflect the number that might have an accession record, barcode or RFID tag so a group of c20 pottery shards might count as 1 object if that is how it is catalogued and stored.

You may want to break these numbers into groups by the type of collection.

2. What percentage of the collection is catalogued?

Please indicate whether this is in machine-readable systems.

#### Locations

3. What is the number of unique locations eg particular room, shelves etc?

4. What is the number of unique containers or holders eg solander and other boxes?

Containers or holders are locations capable of being moved.

#### Movements

5. What is the number of object moves per year for

Conservation

Photography

Research

Exhibitions and displays

External Loans

Reorganisation

This number should reflect any movement you might want to record, not necessarily just those that you record now.

### Staffing

6. How many staff are involved in recording object movements?

You may wish to break this down into categories such as curatorial, conservation, technical

### Procedures

7. How would you describe your current procedures in locations management and object movements?

1 - excellent; 2 - good; 3 - adequate; 4 - in need of attention

### Plans

8. Do you have any major collections moves planned?

9. Do you have any visitor access projects planned, which might be able to utilise object or location specific barcodes or RFID tags?

The answers were examined to identify how decisions could be made on whether to implement machine-readable systems.

## **4.3 Responses to questionnaire**

The responses illustrated major differences in the size of collections and scale of operations amongst the partner museums.

The numbers of collections range from 24,000 to 780,000, staff involved in collections management systems from 5 to 60, movements from 2,000 to 80,000. With the highest number of movements there is almost certainly potential for efficiency savings. There were plans for collections moves involving redisplay, and

storage projects including two involving 'open storage'. Generally, a very high percentage of collections were catalogued in a machine-readable system. Some museums felt the need to improve procedures although all were rated good or adequate.

#### **4.4 Time and resource implications**

It wasn't possible to fully assess the time and resource implications for introducing systems in each museum. There are too many variables (see 4.5). These include policy considerations such as enabling visitors to identify collections more easily in storage or on display, and improving the recording the use of collections for security and statistics. Taking an overview, it seems unlikely that major initiatives would take place outside of major redisplay or storage projects.

Costs would vary depending on the solution chosen. At the upper level, using RFID tags, the cost of tags alone would range from £7,200 to £234,000. The cost of tags is very variable and this is just an illustration. Using 2D tags these costs might be 10% of the above.

In terms of the impact on staff, there is potential in the medium and long-term to improve the speed and accuracy of operations such as locations recording. Reducing errors, which can take a significant time to correct, is also important.

Investing time and resources in putting in place machine-readable systems could be particularly beneficial to future, perhaps unplanned, collection moves when there might be insufficient time to implement a system.

#### **4.5 Decision making aids**

A series of charts provide a graphical way of making decisions about implementation. These appear below.

##### Chart 1 : Business Environment – Information

A framework for analysing information on the museum's business environment.

##### Chart 2 : Choosing technology – barcodes or tags

To assist decisions on which labelling technology to use.

##### Chart 3 : Choosing technology – readers and associated software

To assist decisions on which reader technology to use.

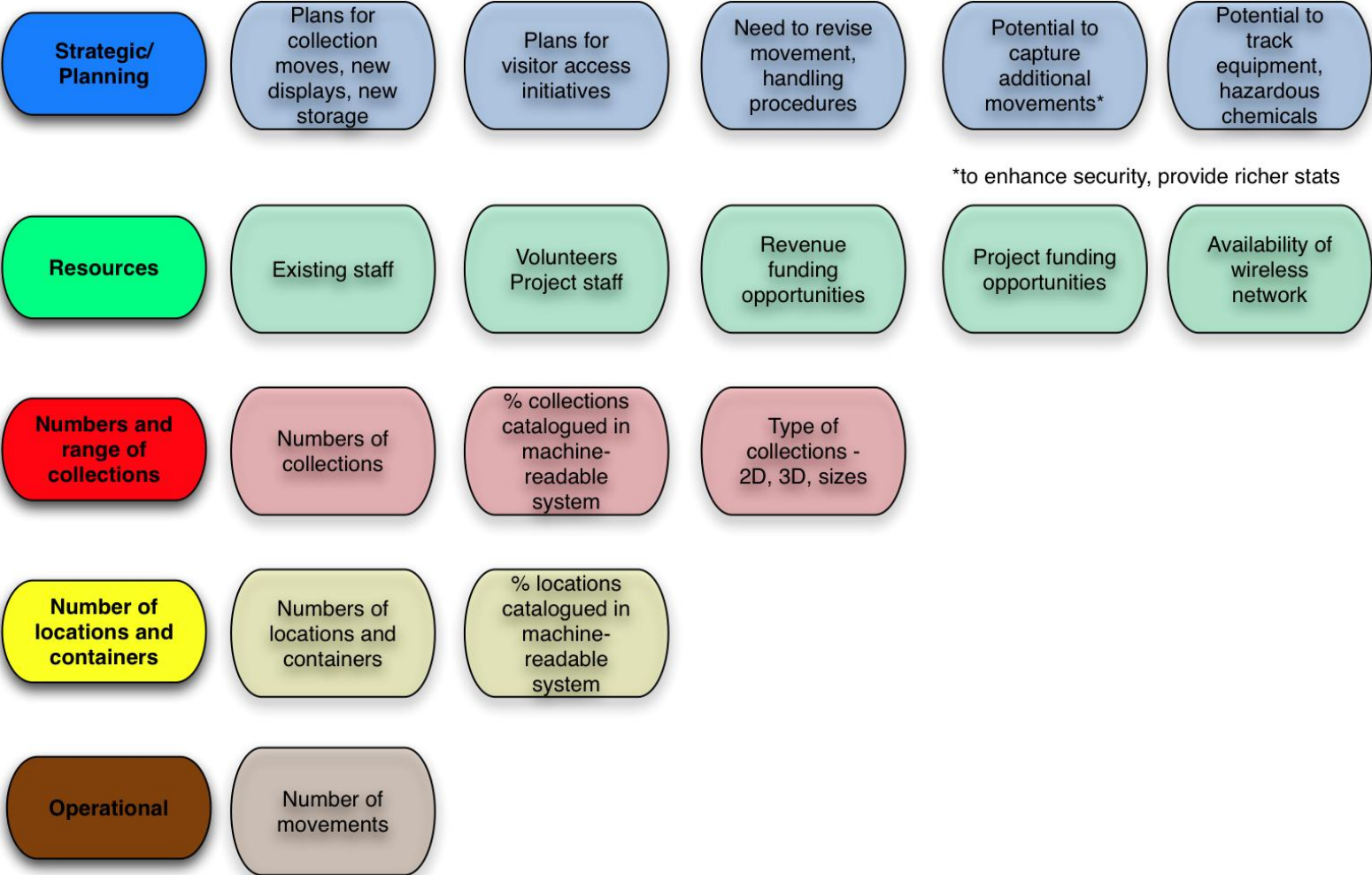
#### **4.6 Collections Management Interfaces**

The partner museums use two different collections management systems, Mimsy XG from Willoughby Associates (Horniman Museum and the Museum of London) and MUSIMS from System Simulation (Geffrye Museum and London Transport Museum).

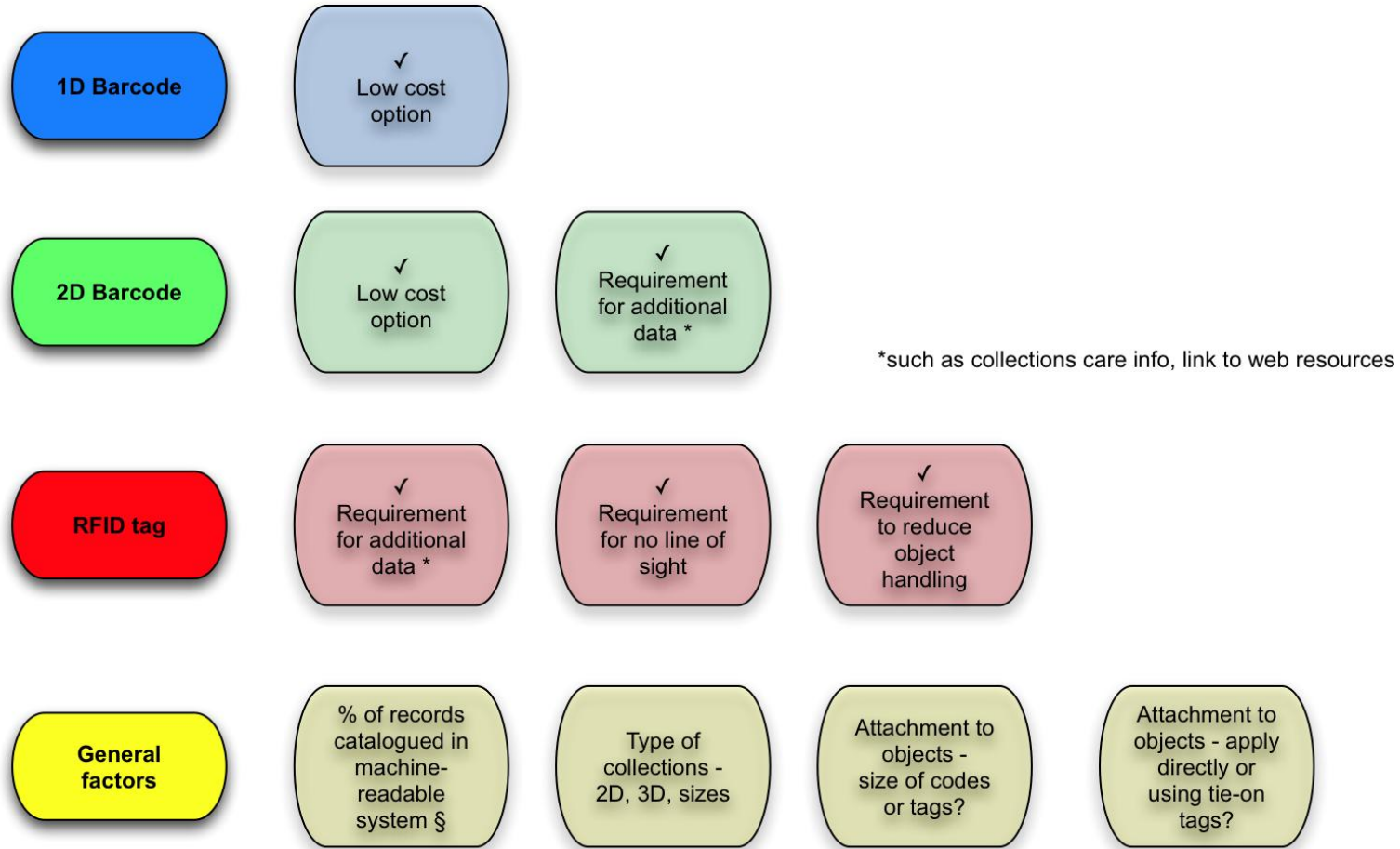
The options for interfacing with these systems are set out in Chart 3. They range from using a barcode/RFID reader simply as a keyboard substitute, to running a program based on the CMS through a Windows interface on a PDA/barcode/RFID reader.

Informal discussions with System Simulation and Willoughby Associates have demonstrated support for such developments and there could be interest from other users, with the potential to share development costs.

**Chart 1 : Business Environment - Information**



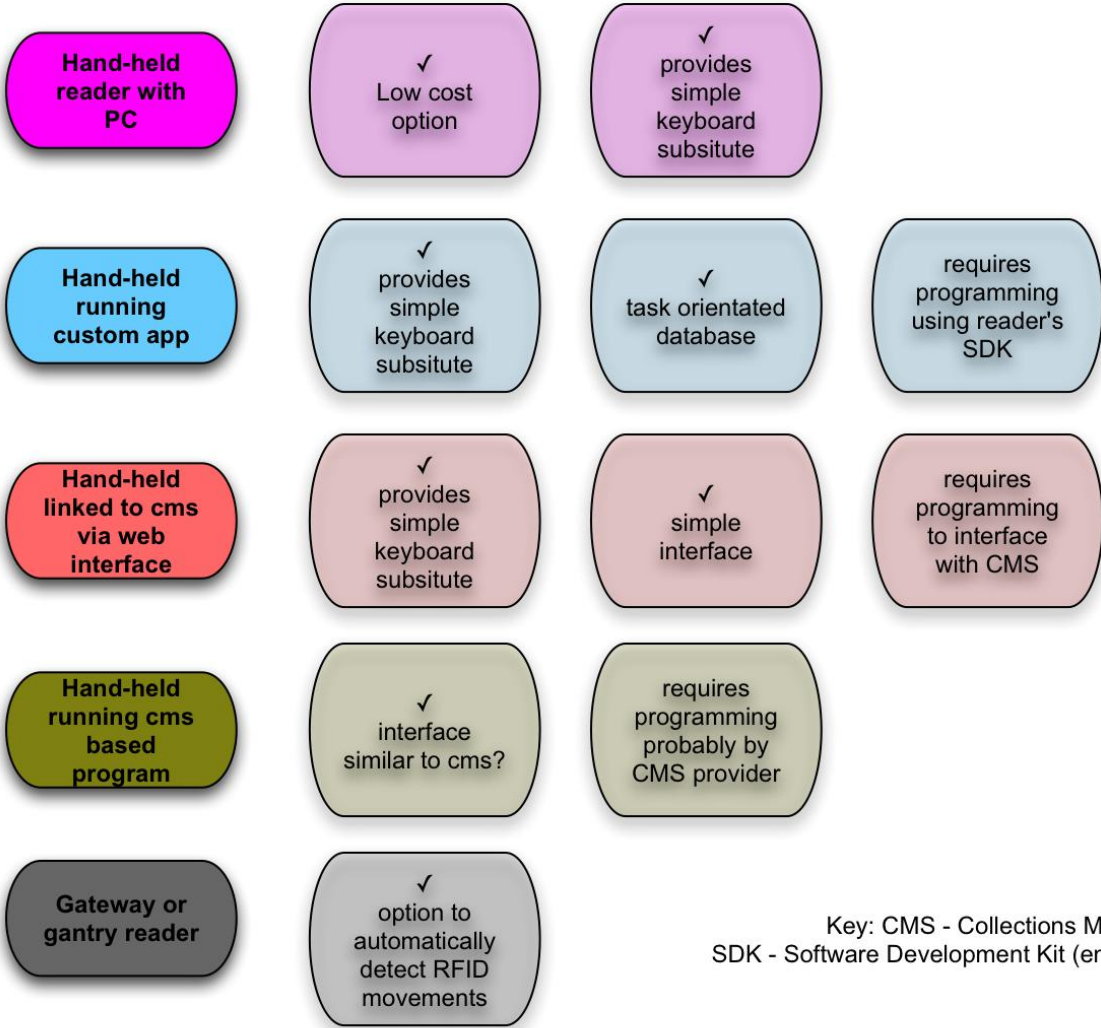
**Chart 2 : Choosing technology - barcodes or tags**



\*such as collections care info, link to web resources

§ barcodes or RFID numbers can be more easily added to records of objects and locations if there is a machine-readable record

**Chart 3 : Choosing technology - readers and associated software**



Key: CMS - Collections Management System;  
 SDK - Software Development Kit (enabling programming of reader)

## Appendix A

### Case Study 1

The Ashmolean Museum of Art, Oxford

#### Project Name

Transforming the Ashmolean. This project was informally called 'The Decant'.

#### Description

Plans, for the transformation of the Ashmolean, required the removal of most of the collections\*, from their former locations in galleries and stores to external storage. Before relocation all objects had basic information recorded in a custom database, and were photographed and barcoded. Barcodes were also generated for locations and containers.

\*Eastern Art, Antiquities and Coins.

#### Technology

9 data stations were established, comprising a laptop computer, barcode scanner, and printer and were staffed with 2-4 decanters. (Fig 9)

A database was created in-house using Microsoft Access to capture data relating to the relocation. Common elements of the accession numbers were pre-loaded into the database to speed up data capture.

Barcodes were attached to containers and locations. These were used to record objects in transit.

Code 128A barcodes were used, with prefixes related to the data type and decant station. The different data types were O=Object, C=Container, L=Location. The decant stations were numbered DS1-DS9. For example the number ODS1-9003 represents a barcode of an Object from Decant Station 1, with the running number

9003. Each decant station had to have a separate number sequence as the stations could not always access the museum's data network.

RFID tags were ruled out on grounds of cost, given the very large numbers of objects that were to be recorded. Barcode readers proved reliable, although because the ones used for the trail systems had no on button and as such were always on, resulting in a tendency for them to read other barcodes accidentally. Gated scanners (ie those with an on button) have been used since.

The workflow involved scanning the pre-printed barcode to create a new record, selecting/entering the accession number or sequence of numbers, recording basic data on the object (including material), the original location, and capturing one or more images (c700kb each). The barcode was included in the photographs. There was a facility in the database to carry over data from one object to another, useful for similar objects. The new location was associated with the object through its barcode.

Standard boxes (containers) were used with clear crystal boxes for smaller items. For loose material, such as shards of pottery, zip-top polythene bags were used as an outer layer with the barcode tied on with a tag. The size of the box was recorded in the database.

c130,000 barcodes were used for c250,000 objects, because some objects were in multiple parts. Just under 1000 locations were identified, with just under 16,000 containers.

Barcodes were covered with a layer of UV filtering film, taken from rolls. This helped secure the label further, protects against abrasion and fading, and being eaten by silverfish.

### Current situation

Some staff employed as decanters have been kept on as retrievers.

Data from the workstations was merged and will be loaded into Zetcom MuseumPlus, the new collections management system acquired since the Decant. This will provide

a skeletal record for many objects which up to the Decant had no electronic record. MuseumPlus is now setup to use barcodes in the logging of movements, and can record and print barcode labels for objects. (Fig 10)

For objects not involved in the Decant there are no plans for barcoding. Given the context of the workload involved in the 'Transforming the Ashmolean' project this is quite understandable. In the Department of Western Art there is also a view that the potential benefits of barcoding the extensive prints and drawings collections would not outweigh the amount of time taken. There are also reservations over the use of barcodes in close proximity to the objects, for instance the barcodes would need to be adhered to the mount of a drawing or cover of a book.

#### Contact

Chris Powell, ICT Officer

#### Links

[www.ashmolean.org](http://www.ashmolean.org)

[www.zetcom.com](http://www.zetcom.com)

## Case Study 2

The Children's Museum of Indianapolis (TCM)

### Description

Since 2006 TCM have worked with the RFID supplier Northern Apex to implement RFID technologies for collections management, with the intention of extending their use to extend visitor access. Museum staff had learned of the benefits of the technologies from the Walker Art Center, Minneapolis.

TCM was founded in 1926. The collections consist of more than 100,000 objects, intended to provide a storehouse of ideas and concepts, in three domains: Natural World, Cultural World and American Experience.

A test was set up with the Lanzendorf art collection of 277 objects. 3-dimensional works, primarily large bronze sculpture and paleoart (dinosaur art) followed. In advance of an exhibition, 'Global Perspectives', to be held in 2009 contemporary Egyptian objects have started to be tagged. These comprise books, CDs, 2 and 3-dimensional artwork, textiles and furnishings. The tags may also be used for security purposes in the exhibition.

### Technology

TCM worked with Northern Apex, the company that had supplied the Walker Art Center, and with KE Software, suppliers of their collections management system, KE EMu. In KE EMu, TCM was able to use the existing barcode/RFID field in the Locations module and had an RFID field added to the Catalogue module.

Using Northern Apex's ARTiFACT TRAC™ software the tags are able to store a significant amount of data. For instance an object's accession number, artist, title, date of last movement, room location, shelf location and identity of person that last moved the work, can be stored directly on the tag. At the TCM the Accession Number, Popular Name (Title) and Current Location are stored.

Conservation staff from TCM were consulted over how to adhere the RFID tags to the objects. As initially these were framed works, it was quite straightforward to add the tags to the frames. The tags, encased in Japanese paper, were supplied by Washi Wrap and also used by the Walker Art Center. (Fig 11). Tags attached with strings are used for 3D objects, with the RFID tag affixed using double-sided tape. (Fig 12). For non-fine art such as books and CDs, tags are applied directly to objects.

### Workflow

Tags were applied to the Lanzendorf art collection from September to December 2006, an inventory report run, and the technology (reader, tags, software) evaluated.

Using a hand-held scanner (Fig 13) the accession number is read into the ARTiFACT TRAC software, which populates the RFID identifier field in the catalogue module in KE EMu.

Location changes are entered manually into KE EMu. All storage locations in the test project have an RFID identifier. In the future it is planned to have the ability to record location changes instantly using the scanner.

### Future Developments

Further work was proposed to use PocketPC based handheld units to communicate with TCM's computer network and KE EMu, thus providing live location and inventory capabilities.

Funding has recently been approved to expand the coverage of RFID in 2008.

### Contact

Jennifer Noffze, Registrar/Archivist, The Children's Museum of Indianapolis

Terry Coonan, Sales Manager, Northern Apex

### Links

[www.childrensmuseum.org](http://www.childrensmuseum.org)

[www.NorthernApex-RFID.com/Artifacttrac.html](http://www.NorthernApex-RFID.com/Artifacttrac.html) [pdf available]

[www.WashiWrap.com](http://www.WashiWrap.com)

### **Case Study 3**

Fitzwilliam Museum, Cambridge

#### Project Names

eGuide


Learning on the Move (NESTA project)

#### Description

The audio-visual eGuide to the Museum was developed with At-Bristol (the science, nature and art discovery centre) and the National Space Centre, Leicester and supported by NESTA (the National Endowment for Science, Technology and the Arts) through the project 'Learning on the Move'. Hypertag developed the tags which identify the works, and the 'Magus Guide' application used at the Fitzwilliam.

The eGuide provides a tour of 20 objects in the museum through a hand-held device lent to visitors who provide a deposit such as an identity card. (Fig 14)

#### Technology

In the galleries, tags are embedded in labels, which carry a logo containing a black triangle.  The tags are infra-red requiring a clear line of sight to be read. Infra-red was chosen by Hypertag as this technology is more commonly supported in PDAs. Hypertag use infra-red and Bluetooth tags for uses outside of museums, for instance in advertising posters. (Fig 15)

Users of the hand-held guide can listen to instructions, view a floor plan showing where the selected objects are located, and control which works they want information on. Once an association has been made with a tag, the guide offers options to listen to/view information about an object or group of objects. The content includes audio commentary, comparative images, interactives and video.

The guides, Dell Axim X51v PDAs, have a touch screen which can also be activated through the supplied stylus. The devices run Microsoft Windows Mobile 5.0, have

support for Bluetooth, 801.11b wireless networking and infra-red, although only the latter is used.

In the planning stages, an interface for accessing the collections database using the wireless network was envisaged but as yet has not been developed further. Instead there is a bank of computers in one of the galleries providing access to the Museum's website.

### Future developments

Evaluation of the eGuide with users has led to plans for a new system to be provided by Antenna Audio. A more robust hand-held device with a touch screen will offer information on 50 objects, rather than 20 as now. Tags will no longer be used to activate the guide (although in the future they might be used for location finding). The Museum will have more control over updating subject matter through a content build system. The new service will be charged for.

### Contacts

David Scruton, Documentation and Access Manager

### Links

[www.fitzwilliam.cam.ac.uk](http://www.fitzwilliam.cam.ac.uk)

<http://www.hypertag.com/>

## **Case Study 4**

Gemeentemuseum, The Hague

Helicon Conservation Support

### Project Name

Adlib Museum Tracker

### Description

The Gemeentemuseum houses a collection of c140,000 objects, in three sub-groups:  
Modern Art: paintings, drawings, prints, photographs and sculpture;  
Applied Art: furniture, carpets, costume, glass, silver and ceramics;  
Music: western, non-western and electronic instruments.

The museum is one of a number in the Netherlands that have used machine-readable systems in conjunction with Adlib, the leading supplier of collections management software in that country.

Barcodes were first used to identify 80% of their collection in 1996/7, during a renovation. (Fig 16) However, the barcodes were never formally used and when staff revisited the situation ten years later they chose to pursue RFID technology. This followed an audit by the Municipality of The Hague. Estimates were obtained to undertake a central locations registration system but were found to be too expensive and the decision was then made to carry out the work in house by collections care staff.

### Technology

RFID tags were chosen as they didn't require line of sight. They could, for instance, be read through picture frames allowing staff to identify works without turning them around. Adlib Museum Tracker software, running on Datalogic DLB JET PDAs, was selected for use with RFID tags. Six readers were purchased so that each department would have two. Helicon Conservation Support provided the system solution, supplying the equipment from Hescon, an RFID specialist. The cost for the

hardware (PDAs, two mobile and one static workstation and tags for 20,000 locations), software from Adlib, and support and advice from Helicon was €100,000.

A separate security system also uses RFID tags.

The Adlib Museum Tracker system is also in use at Helicon, where museum collections are held in store. At this location two types of Philips I-CODE® tag are in use, a credit-card size tag encapsulated in polyethylene (Fig 17) and a button size tag (Fig 18). Tags are either attached to objects directly using polyvinyl acetate adhesive, or indirectly on tie-on labels. When attached directly the tags are fixed to the lowest horizontal right-hand side part.

For objects, information is written on the tag in code form to describe collections care requirements such as its recommended environment. This makes use of the 42 available fields in the tags.

### Workflow

Collections care staff in The Hague identified several phases to implementation. The first was to identify locations with RFID tags. Location identities are written to the tags and, for metal storage units, the adhesive-based tags are adhered to magnetic strips which then attached to the shelves. The strips provide some insulation for the tags.

### Future Development

The second phase in the Gemeentemuseum is to match object barcodes with location tags. The third is to replace the barcode labels with RFID tags. The cost of these phases is expected to match the investment in Phase 1.

A wireless network will be installed in the stores to provide access to the Adlib database. Staff are currently researching the reliability and security of such a network.

### Contact

Elmar Groen, Coordinator Conservation and Management, Gemeentemuseum, The Hague

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Wouter Hijnberg, Helicon Conservation Support bv, Alphen aan den Rijn

### Links

<http://www.gemeentemuseum.nl/index.php?id=1&langId=en>

<http://www.helicon-cs.com/en/index.html>

<http://www.adlibsoft.com/>

<http://www.hescon.nl/>

## **Case Study 5**

Great North Museum, Newcastle

### Project Name

The Application of Radio Frequency Identification (RFID) Track and Trace Technology in Museum Based Collections Management

### Description

This pilot project was an evaluation of RFID technologies supported by the Arts and Humanities Research Council (AHRC). It was part of the Great North Museum project, which will establish a new museum in the University of Newcastle in 2009. The intention of the pilot undertaken in 2005/6 was to test the methodology, practicality and benefits of tagging a wide range of objects from the University's museums. It related to the relocation of the Hancock Museum collections to a temporary store. A comprehensive report was produced (see below).

### Technology

A leading RFID supplier Intellident, with experience in the library sector, worked with curatorial and ICT staff from the museum, and Tyne and Wear's curatorial and conservation staff. The pilot system was developed to work with MODES for Windows, the museum's collections management system.

13.56mhz Philips i-code RFID tags were chosen, each 43mm square and supplied with adhesive backing. However, the tags were found to be too large for the forward face of some storage drawers.

A hand-held reader using software based on Intellident's Library management system provided three functions: Locations update, Item Discovery and Item Inventory. The reader weighing just under 1kg proved difficult to handle, and a potential risk to objects. The battery level lasted only 2 hours in heavy use.

### Workflow

Eight collections were selected for the trial – Geology, Entomology, Oology, Taxidermy animals, Malacology, Osteology, Fine Art, Archaeology, Egyptology and Ethnography.

The first process was to associate the tags with the MODES inventory database using a PC running the Tag Apply software, and an electronic mat. The tags were associated with the MODES records through the tag number being identified then copied and pasted into the MODES record. For locations, the tags were written to with the location data. (Fig 19) The process of copying and pasting caused errors.

File Parser software on the PC was used to synchronise data to and from the hand-held reader. An early bug in the software caused problems which were fixed in a later version.

Data was transferred from and to MODES using the CSV (Comma Separated Values) format. In the case of import into MODES, the CSV files needed conversion to the TAG format used by MODES. More recent version of MODES supports XML import which should assist this process.

Analysis of functions:

Locations Update – enabled locations of storage units and objects to be updated by scanning the location tag, then the unit tag (location or object). (Fig 20)

Item Discovery - identified storage units or objects at a selected storage location. (Fig 21)

Item Inventory – created a record of locations and the storage units or objects in that location.

Error messages were displayed when essential data such as the item data was not available on the hand-held device.

The inventory data appears in the MODES record for a storage unit as a list of objects, together with a reference to an associated photograph. (Fig 22)

The tagging system was only able to support two levels of tracking information eg on unit tag (location or object) and one level of storage information. What was wanted was the ability to track three levels such as locations/storage units/objects.

In the case of storage units eg drawers, tags were either directly attached, or adhered to an acid-free tag which was attached with cord. The latter technique was used for identifying objects.

#### Testing the tags for readability and durability

Extensive testing was carried out to discover the extent to which tags would be readable in certain situations such as within display cases, under wrapping and in crowded storage. The results were mixed. Of particular concern was the difficulty of reading tags in boxes and drawers. This may in part be due to the limitations in the direction of scanning in the hand-held scanner eg a tag presented at a right angle would be difficult if impossible to read. The failure to read some tags removed the advantage of RFID in being able to avoid 'line of sight' reading.

Tags adhered to metal surfaces needed insulating material between the tag and the metal.

#### Testing adhesives

An Oddy Test (accelerated aging test) was carried out on the tags to test the adhesive. The test produced heavier than expected oxidation on the Copper and Lead tokens. Conservation staff advised that the tags should not be adhered to or be in proximity to museum objects but were happy with them being applied to the exterior of packing crates. Options to manage the former issue were to use conservation grade adhesives, or encapsulate the RFID tag.

There were problems in tests for adherence as follows:

- wooden cupboards (tags fell out, on both varnished and unvarnished surfaces)
- metal storage (tags were OK on clean flat surfaces but not when edges were folded)
- glass jars (jars contaminated with grease and chemicals were unusable)

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- polythene sheeting (was OK)
- plastic crates (clean ones were OK)

Extreme testing was done:

- Freezing (tags worked after 5 days)
- Spillages – spirit fluid, water (tags failed to work)

### Contact

Steve McLean, Project Manager and Senior Curator

### Links

[www.greatnorthmuseum.org/](http://www.greatnorthmuseum.org/)

[www.intellident.co.uk](http://www.intellident.co.uk)

A comprehensive report was published 'The Application of Radio Frequency Identification (RFID) Track and Trace Technology in Museum Based Collections Management', Joanne Anderson, Steve McLean, Linda Morris, April 2007

## **Case Study 6**

Museum Victoria, Melbourne

The Powerhouse Museum, Sydney

### Project Name

MVWISE

### Description

MVWISE is a web interface to the collections management system KE EMu. Museum Victoria developed it for inventory management and it was first named MvCIS (Museum Victoria Collections Inventory System). KE Software was founded in Melbourne, and the museum commissioned the software company to develop KE EMu.

It was renamed MVWISE (Museum Victoria Wireless Input System) to help describe its more widespread application in providing an interface to KE EMu. Originally it only interfaced with the Catalogue and Location modules.

It is used by six museums in Australia and the USA, including Museum Victoria and the Powerhouse Museum. Powerhouse currently uses MvCIS but is planning to move to MVWISE.

The Powerhouse Museum, Australia's largest and most popular museum, is located in Darling Harbour, Sydney. Its diverse collection of 385,000 objects spans history, science, technology, design, industry, decorative arts, music, transport and space exploration.

Museum Victoria is the State of Victoria's museum, responsible for more than 16 million individual items. These objects are organised within three collections - Sciences, Indigenous, History and Technology.

### Technology

The home page for MVWISE gives various options to manage data on objects, locations, parties (people and organisations). (Fig 23) MVWISE manages the display of information through panels to make best use of the small screen found on PDAs. These panels can be expanded or contracted, for instance to allow images of objects to be displayed easily. (Fig 24)

MVWISE runs on PDAs through the web browser, and relies on access to a KE EMu server. By default it uses the same security settings as the KE EMu client but this can be overwritten. Although the sites use MVWISE with barcodes, the software can read (but not write to) RFID tags.

The system does not allow batch collection and loading for a number of reasons: The number of records and amount of data to download to PDA may be excessive; the system would not provide for the same level of data validation as in KE EMu; errors that may occur in updating are avoided.

MVWISE requires a server running Microsoft IIS (Internet Information Server), with .NET Framework installed.

Both Australian museums use pre-allocated barcodes printed by an external supplier, which was found to be a cheaper solution to printing in-house. Code 39 is used by Museum Victoria while Code 128 is used by Powerhouse.

An error rate of up to 10% in data entry was experienced before the introduction of MvCIS at the Powerhouse, but this has now reduced this to virtually zero.

The Powerhouse selected barcodes rather than RFID tags for several reasons. They did not believe that the advantage of RFID tags not needing line of sight was significant given that objects would need to be handled. There was also the added cost and larger size of the RFID tags.

Using wireless networking can be problematic for a number of reasons, not all easy to account for. Some limitations were found with in stores containing a large number of metal cupboards. In these cases MVWISE can run more slowly.

### Workflow

At Museum Victoria, barcodes are never attached to objects and small objects are not barcoded. This is not a problem for MVWISE as data can be entered manually. Three staff are employed to deal with transactions using MVWISE. There is a strong commitment to clear processes and procedures, staff training and involvement which brings benefits in terms of the success of the technologies.

The Powerhouse introduced MvCIS to manage a major store relocation. Extension of its use has so far been limited by the need to await the installation of wireless networking. Large objects carry the barcode, while for small and fragile objects the container is barcoded. Barcodes are attached to standard tags tied to objects.

Barcodes are also used for locations and holders (this is the name used in KE EMu for boxes, containers etc).

### Future Development

Museum Victoria is looking into using MVWISE for other data capture projects such as an audit of selected hazardous substances in the collections.

The latest development roadmap for MVWISE was dated 11 December 2007 (accessed 4 February 2008).

### Contacts

Forbes Hawkins, Collections Systems Developer, Museum Victoria

Natalia Fraser, Manager, Collection Location Systems, Museum Victoria

Lynne McNairn, Systems Administrator, Collection Information System, the Powerhouse Museum

### Links

MVWISE site - [mvwise.museum.vic.gov.au/Home.htm](http://mvwise.museum.vic.gov.au/Home.htm)

Presentation on MVWISE at KE EMu users meeting in London in 2006 -

[www.emuusers.org/Portals/0/Melbourne 2005/Presentations/03\\_MVWISE.pps](http://www.emuusers.org/Portals/0/Melbourne%202005/Presentations/03_MVWISE.pps)

[site requires registration]

[www.powerhousemuseum.com](http://www.powerhousemuseum.com)

[www.museum.vic.gov.au](http://www.museum.vic.gov.au)

## **Case Study 7**

Manchester City Galleries

### Project Name

Revealing Histories: Remembering Slavery Gallery Trail

### Description

A pilot of 2D barcodes, taking place from 1-29 March 2008, was set up in an existing display 'Revealing Histories: Remembering Slavery'. The display had already invited visitors to create their own label on the six objects on show through paper-based forms available in a trail leaflet. The pilot was intended to assess how visitors might use 2D barcodes to access information, and submit content through their mobile phones. (Fig 3)

The Gallery saw the pilot as a way of helping inform future digital developments by enhancing gallery interpretation, engaging audiences through digital technologies, providing a fun, easy way for direct interactivity and dialogue with visitors, and making effective use of increasingly commonplace technology that visitors use on a daily basis.

### Technology

QR (Quick Response) code was chosen for the pilot as it was open source, commonly supported and relatively compact. Mounted at an angle in the showcases the codes were printed quite large to maximise readability. (Fig 25 and 26) Good lighting was also found to be necessary to read the codes. One of the attractions of using the technology was that the cost of printing the codes using a standard black and white printer was minimal.

It was understood that only a minority of visitors would be familiar with the technology as it has not been widely used and in the UK it is only supported by a small number of phones. Some new phones, such as the Nokia N95, ship with the barcode reader software. For others, the software can be downloaded from the Internet.

Specially created web pages were created by Matt Haworth, Revealing Histories Web Coordinator, to deliver content that would be quick to download and easy to read on smaller screens.

### Feedback

Julian Tomlin and Matt Haworth were available in the Gallery during Saturday 1 March to support use by visitors. As expected only a small number of visitors made use of the codes. One immediate barrier was a reluctance to use the Internet on visitor's mobile phones. When asked, users that had the capability of accessing the Internet on their phone replied that they didn't use it because of the cost, or lack of familiarity - it was just another 'feature'.

It was encouraging to learn from web statistics that over 150 people accessed the codes using mobile phones in the first two weeks of the pilot. However, this figure includes those who may have scanned the codes from on-line reports and marketing material. 2 users submitted content.

For those using the codes, the trial proved effective in providing links to the dedicated web pages, in one case, the 'Bonbonniere', had links to audio files relating to the object. (Fig 27)

### Contact

Helena Wetterberg, Community Interpretation Officer, Manchester City Galleries  
Matt Haworth, Revealing Histories Web Coordinator

### Links

<http://www.manchestercitygalleries.org.uk>

<http://www.revealinghistories.org.uk>

<http://www.revealing-histories.org.uk/mobile/trail-mag/>

<http://www.revealing-histories.org.uk/mobile/trail-mag/bonbonniere.php>

<http://mobilecodes.nokia.com/index.htm>

<http://reader.kaywa.com/>

## **Case Study 8**

National Museum of Malaysia, Kuala Lumpur

### Description

The National Museum has a four-year programme, begun in December 2006, to tag all collections and storage locations.

The Malaysian government is encouraging the use of RFID technologies and the chosen supplier, CBS Technology, is based in Kuala Lumpur.

The first group of objects to be tagged was a collection of c1000 weapons where the tags replace hand written cards. The intention is to tag the remaining objects, numbering c300,000.

### Technology

RFID tags were chosen over barcodes was that they were available in different shapes and sizes.

The tags used with the weapons collection are from various manufacturers, made from flexible plastic, and attached with custom-designed string. There are plans to sew tags into costume items.

CBS Technology's Solmate software is used to manage locations and loans.

### Workflow

The tag is encoded, using a stationery interrogator, with the object's ID number, type, owner and location. The tag is then attached to the object. Each storage location has its own RFID tag.

For loans management, the initial request is logged on the database, and information on the objects and their locations retrieved. The staff member then goes to the locations, and uses a hand-held interrogator to identify the requested objects. Once the objects are removed the manager approves the loan on the database. The tags

are read when the objects are shipped, using a desktop reader near the exit. The system supports the return of objects to their original location.

#### Contact

Zawawi Itam Osman, Registrar, National Museum, Kuala Lumpur

Ken Lee, Chief Technology Officer, CBS Technology Berhad, Kuala Lumpur

#### Links

<http://www.museum.gov.my/>

<http://www.cbs.com.my/english/solutions/rfid.htm>

## **Case Study 9**

Norfolk Museums and Archives Service

### Description

Norfolk started using barcodes to record and manage the removal of objects in relation to various collection moves, firstly in 1999 with the refurbishment of the Castle Museum, Norwich.

Barcodes were used to identify packages, such as boxes or framed paintings, rather than specific objects. Since the wider adoption of this approach, there are now c28,000 containers identified with barcodes across the service. In 80 stores there are also thousands of locations identified with barcodes. There is an intention to use barcodes in all-remaining storage containers and locations.

### Technology

Barcodes are printed in-house from Avery LabelPro software. MODES for Windows is used as the collections management system, and MODES database files were created to manage containers, and for audits.

Initially Code 39 barcodes were used. These were later replaced by Code 128C which gave more flexibility in naming eg supporting the use of forward slashes for storage locations. The labels contain a running number, including a prefix to identify the area of the collection that the container related to eg AS12355 where A stands for Archaeology. This provides a link from the containers with curatorial staff overseeing the moves. An advantage in using anonymous numbers was that it was not possible to identify valuable works, as it might be from using accession numbers.

Standard office labels are used to attach to containers. Branded ones proved to be of better quality but there remains a problem with the poor adhesion of labels.

Transparent label protectors are being looked at to improve this situation.

The original barcode scanner was later replaced with a Bluetooth wireless type, working from a plug in base station and having a nominal range of up to 100 metres.

When tackling audits of the collection accession numbers are not used as many of the objects have accession numbers too long to be easily converted into a barcode.

### Workflow

The barcode scanner is used to read and store the container number and the location. This data is held in the scanner, and exported for editing into Excel. The raw data only contains one reference for each unique location, so it is edited in order to repeat locations for each container.

The data is then converted into a MODES tag file. These files are used for interchanging information within MODES, and consist of structured lists of field names followed by data. The container number acts as the MODES record number.

Small-scale object moves still use paper forms, which are then entered in MODES by other staff.

For auditing purposes, barcodes have been used as follows. A set of labels is printed outside of MODES, since the version of the program used didn't have the capability to print barcodes. The labels contain an audit number eg AUD14 and a brief description from MODES, to help identification. (Fig 1). In the example of the paintings collection, the barcode labels were matched up with works and adhered to frames or tied on. When no object was found, the object was marked as missing from its location. When no barcode label was found, the object was not recorded in MODES and a new record was created.

Some tasks, such as the transfer of data from the scanner to MODES, may avoid the need for manual editing and thus be easier with the current version of MODES for Windows, ModesXML.

### Costs

The original costs were £400 for the scanner and £50 for the barcode software. The total cost of the removal of works from the Castle Museum, and their temporary storage was £160k.

Further development

Barcodes are seen as useful in recording emergency evacuations and this approach will be adopted in future emergency planning.

Contact

Martin Warren, Collections and Information Manager

Links

[www.museums.norfolk.gov.uk](http://www.museums.norfolk.gov.uk)

<http://www.modes.org.uk/>

## **Case Study 10**

The Petrie Museum, London

### Project Title

Conservation Audit

### Description

Barcodes were created and associated with objects and locations, as part of a conservation audit of the whole collection, carried out from July 2003-June 2004. The collection covers approx 80,000 objects from Egypt and the Sudan from Palaeolithic through to the Islamic period.

### Background

The Petrie had benefited from Designation Challenge Funding which resulted in the collection being photographed, catalogued in an Adlib database, and published online at [www.petrie.ucl.ac.uk](http://www.petrie.ucl.ac.uk)

The aim of the project was to investigate the use of machine-readable tags to link to the catalogue. As well as improving collections management, it would allow better recording of the heavy use of the collection in teaching, particularly important to a university museum. It would also help the eventual relocation of the collection in purpose-built galleries within a new building, The 'Panopticon'.

It would also provide a way of identifying the objects in the densely packed displays so as to facilitate retrieval of improved interpretation through hand-held devices. The current labels which are based on a long-standing academic model are not considered suitable for many audiences.

A test was carried out earlier to test assess technologies and methods (see below)

### Technology

RFID tags were examined since they had the advantage over barcodes of not needing line of sight to read them but were rejected on several grounds. The costs of

the tags was estimated at £24,000 (or 30p each), the tags themselves were credit card size, much larger than many of the objects and they only had a guaranteed life of 10 years. Barcodes were therefore selected as they could be produced cheaply through printing on standard office printers. The costs and sizes of common RFID tags have since fallen.

Code 128C barcodes were selected, as they were smaller than the other popular symbology Code 39. They were produced in a simple numerical sequence, printed out 20 per page onto 160gsm archival card, then cut to size.

The numbers were prefixed '0017' representing the MDA code for the museum. This ensured that the numbers would not duplicate any others produced at a later date for other museums in University College, London.

Barcode readers were extensively tested, in terms of accuracy and range, particularly with their placement in glass cases. The readers were found to have problems with reach into some cases and having too wide a reading width.

Initial testing had shown that using the main Adlib database was slow so a separate database was created, not linked to the main database. The accession numbers were handwritten on the barcodes. This was felt to be speedier than pre-printing the accession numbers on the barcodes, as the objects were not dealt with in accession number order and the numbers are quite short (often only 5 numbers).

Experiments were carried out with a hand-held device, a Hewlett Packard iPaq with a display of 320 x 240 pixels. This proved effective in retrieving data (an image and basic data) from a networked database using the object barcodes. However, security upgrades to the wireless network meant that this model was later blocked from accessing the network.

### Workflow

The audit was carried out in the galleries using a trolley containing a laptop computer and hand-held scanner. A Wi-Fi connection was used to connect to the networked database.

The nature of the collection, particularly the size of the objects, meant that the card containing the barcode was not appropriate to adhere directly to the objects.

The pre-printed labels were placed in polystyrene 'Cristal' boxes and, in the case of older containers placed loosely in the boxes. This risked them becoming detached but the intention was to transfer all objects into suitable conservation approved containers. (Fig 28). Some objects were too large for containers and others were placed in polyester pockets, with the barcode tied on.

For the items on display, the barcodes are usually gathered together, for instance at the end of the shelf. (Fig 29)

At the end of the audit, to provide simplified access to staff, the data was exported into two Microsoft Access databases, one for conservation data, and the other for locations data. Lack of staff time has so far prevented this data being merged with the main Adlib database.

A comprehensive report 'Object tagging at the Petrie Museum', Ivor Pridden, July 2003 is available from the Petrie's web site <http://www.petrie.ucl.ac.uk/barcodes.pdf>

### Current situation

The version of Adlib used did not run on PDAs, but the current version can now run in batch mode, working separately to the main database.

Staff can use handhelds or barcode readers to record movements for exhibition, loans, conservation and research but barcodes are not actively used in collections management and access. This should change when the data from the audit (conservation state and location) is loaded into the Adlib database.

With barcodes and images having been recorded for all objects, the Petrie is an excellent position to manage the move to the new galleries in 2010.

### Contact

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Ivor Pridden, Project Conservator/Honorary Research Assistant

Links

<http://www.petrie.ucl.ac.uk>

<http://www.adlibsoft.com/>

## Appendix B: Database of Past, Present and Future Installations and Suppliers

Sorted by Museum, then Supplier

Project Name	Technology	Application	Museum	Supplier	CMS	Description	Latest Date
Adlib Museum Tracker	barcode RFID	collections management		<a href="#">Adlib Helicon Conservation Support by</a>	<a href="#">Adlib</a>	see Case Study 4	2008
	infra-red	visitor access/learning		<a href="#">Antenna Audio</a>			2005
	barcode			<a href="#">Barcode Readers Ltd</a>			2008
	RFID	collections management		<a href="#">Helicon Conservation Support by</a>	<a href="#">Adlib</a>	see Case Study 4	2008
Magus	RFID infra-red Bluetooth	visitor access/learning		<a href="#">Hypertag Ltd</a>		see Case Study 3 PDA based guide	2008
MVWISE	barcode	collections management		<a href="#">Museum Victoria MVWISE</a>	<a href="#">KE EMu</a>	see case study 6	2008
	RFID			<a href="#">NJE Consulting, Richmond, British Columbia, Canada</a>		investigated for local museum but not pursued	2006
		collections management security		<a href="#">Oat Systems</a>		supplied advice to Sothebys on new system	2008
	barcode	collections management	<a href="#">Antonio J Waring Jr Archaeological Laboratory, Carrollton, Georgia</a>				2002

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Transforming the Ashmolean/ The Decant	barcode	collections management	<a href="#">Ashmolean Museum, Oxford</a>		<a href="#">Zetcom, MuseumPlus</a>	see Case Study 1	2008
	barcode	collections management	<a href="#">Asian Art Museum of San Francisco</a>			entire collection	2002
	RFID	visitor access/learning	<a href="#">At-Bristol</a>	<a href="#">Hypertag Ltd - Magus</a>		see Case Study 3 PDA based guide	2005
	RFID	visitor access/learning	<a href="#">Austrian Technical Museum, Vienna</a>			smartcards	2006
	barcode	collections management	<a href="#">Autry National Center, Los Angeles</a>		<a href="#">Mimsy</a>		2005
	barcode	collections management	<a href="#">Carnegie Museums, Pittsburgh</a>	<a href="#">MVWISE</a>	<a href="#">KE EMu</a>	see Case Study 6	2008
	RFID	collections management visitor access/learning	<a href="#">The Children's Museum, Indianapolis</a>	<a href="#">Northern Apex</a>	<a href="#">KE EMu</a>	see Case Study 2	2007
	barcode	collections management	<a href="#">Computer History Museum, Mountain View, California</a>		<a href="#">Mimsy</a>		
TaggedX	RFID	visitor access/learning	<a href="#">Danish Museum of Natural History</a>	<a href="#">Innovation Lab (Project Coordinator)</a>		PDA's providing information on 50 stuffed birds	2004
	barcode	collections management	<a href="#">English Heritage</a>			trial with archaeology/architectural stonework	1980s
	RFID	visitor access/learning	<a href="#">Exploratorium, San Francisco</a>			two studies, the first with PDA's with exhibit related content delivered over a	2005

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						wireless network, the second allowed visitor to record their experience for later retrieval	
	barcode	collections management	<a href="#">Fine Arts Museums, San Francisco</a>				2007
eGuide	RFID	visitor access/learning	<a href="#">Fitzwilliam, Cambridge</a>	<a href="#">Hypertag Ltd - Magus</a>		see Case Study 3 PDA based guide	2008
	barcode RFID	collections management	<a href="#">Gemeentemuseum, The Hague</a>		<a href="#">Adlib</a>	see Case Study 4 Barcodes in 1996/7, currently using RFID	2008
	RFID	security	<a href="#">Grand Palais, Paris</a>				
	RFID	collections management	<a href="#">Great North Museum</a>	<a href="#">Intelligent, Stockport</a>	<a href="#">MODES for Windows</a>	See Case Study 5 trial extensively documented in a report	2007
	barcode	collections management	<a href="#">Hampshire County Museums</a>		<a href="#">MODES for Windows</a>	trial on the natural science collections	2008
	barcode	collections management	<a href="#">Harvard University Art Museums</a>				2002
	RFID	visitor access/learning	<a href="#">Hunt Museum, Limerick</a>			tagged objects used to prompt interactive displays	
	RFID	collections management	<a href="#">Kroller Muller Museum, Amsterdam</a>				2002
PESEL	RFID	collections management	<a href="#">Kunstsammlung Nordrhein-Westfalen K20/K21, Dusseldorf</a>	<a href="#">Panmobil Systems Hasenkamp</a>		national project working with major art handling company	2008

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	infra-red	visitor access/learning	<a href="#">La Cité des Sciences et de l'Industrie, Paris</a>			exhibitions tour. Barcodes for visitors to record routes within exhibitions.	2005
	RFID	visitor access/learning	Lazio Museums	<a href="#">University of the Studies of Rome "La Sapienza"</a>			2006
	RFID	security	<a href="#">Legoland, Denmark</a>			tracking lost children	2005
Genie	RFID	visitor access/learning	<a href="#">Magda, Rotherham</a>	<a href="#">Genie, Gamesauce, Blink</a>		Tablet PC with RFID reader	2006
	barcode (QR)	visitor access/learning	<a href="#">Manchester City Galleries</a>			see Case Study 7 pilot of QR codes in Revealing Histories: Remembering Slavery display	2008
	RFID	visitor access/learning	<a href="#">Miami Museum of Science &amp; Planetarium</a>				2005
MSYS	barcode	collections management security	<a href="#">Momart</a>			bespoke system, MSYS	2008
	barcode RFID	collections management	<a href="#">Municipal Museum of The Hague (Gemeetmuseum)</a>		<a href="#">Adlib</a>	whole collection identified with barcodes in 1996/7, now being identified with RFID tags.	2008
	RFID	security	<a href="#">Musée d'Art Contemporain, Vitry-sur-Seine</a>				
	barcode	collections management	<a href="#">Musée des Arts et Métiers, Paris</a>			relocation of collections	1998

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	RFID	collections management	<a href="#">Museum Boijmans Van Beuningen, Rotterdam</a>	<a href="#">Helicon Conservation Support</a>	<a href="#">Adlib</a>	trial with 15,000 drawings	
	barcode	collections management	<a href="#">Museum of International Folk Art, Santa Fe, New Mexico</a>		<a href="#">Mimsy XG</a>		2007
	barcode	collections management	<a href="#">Museum of Texas Tech University</a>			mammal collection	1998
	RFID	visitor access/learning	<a href="#">Museum of the Origins of Man, Rome</a>	<a href="#">University of the Studies of Rome "La Sapienza"</a>			2007
	barcode	collections management	<a href="#">Museum Victoria, Melbourne</a>	<a href="#">MVWISE</a>	<a href="#">KE EMu</a>	see Case Study 6	2008
	RFID	security	<a href="#">National Gallery, London</a>	<a href="#">ISIS (Aspects Arts™ active tag system)</a>		stand-alone security system in widespread use	2008
	barcode	collections management	<a href="#">National Museum of Egyptian Civilisation, Cairo</a>		<a href="#">FileMaker Pro</a>		2007
	RFID	visitor access/learning	<a href="#">National Museum of Korea, Seoul</a>	<a href="#">CinTel Corp</a>		PDA's to deliver audio and video	2005
	RFID	collections management	<a href="#">National Museum of Malaysia, Kuala Lumpur</a>	<a href="#">CBS Technology</a>		see Case Study 8	2007

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	barcode	collections management	<a href="#">National Museum of Natural History, Smithsonian Institution</a>				2002
	RFID	visitor access/learning	<a href="#">National Space Centre, Leicester</a>	<a href="#">Hypertag Ltd - Magus</a>		see Case Study 3 PDA based guide	2005
	barcode	collections management	<a href="#">Norfolk Museums and Archaeology Service</a>		<a href="#">MODES for Windows</a>	see Case Study 9	2008
	barcode	collections management	<a href="#">Petrie Museum</a>		<a href="#">Adlib</a>	see Case Study 10	2008
	RFID	visitor access/learning	<a href="#">Potteries Museum, Stoke</a>	<a href="#">Hypertag Ltd - Magus</a>		see Case Study 3 PDA based guide	2005
	barcode	collections management	<a href="#">Powerhouse, Sydney</a>	<a href="#">MVWISE</a>	<a href="#">KE EMu</a>	see Case Study 6	2008
	barcode	collections management	<a href="#">Musée du Quai Branly, Paris</a>		<a href="#">TMS</a>	c250,000 objects identified	2008
	barcode	collections management security	<a href="#">Sothebys</a>			current system under review	2008
	barcode	collections management	<a href="#">Strong National Museum of Play, Rochester, New York</a>				2002
	RFID	visitor access/learning	<a href="#">Tech Museum, San Jose</a>			wristbands to record objects for later retrieval	2005
	barcode	collections management	<a href="#">UBC Museum of Anthropology, Vancouver</a>		<a href="#">FileMaker Pro Multi-Mimsy</a>		2007

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	RFID	security	<a href="#">Victoria and Albert Museum, London</a>	<a href="#">ISIS (Aspects Arts™ active tag system)</a>		stand-alone security system in widespread use	2008
	RFID	visitor access/learning	<a href="#">Victoria and Albert Museum, London</a>			under consideration	2008
	RFID	collections management	<a href="#">Walker Art Center, Minneapolis</a>	<a href="#">Washi Wrap™ LLC</a>	<a href="#">KE EMu</a>	extension of system to provide visitor access planned	2008

Site visits were made to the Ashmolean Museum; Fitzwilliam Museum; Gemeentemuseum, The Hague; Helicon Conservation Support; Manchester City Galleries; Norfolk Museums and Archives Service; and the Petrie Museum.

## **Appendix C: Acknowledgements**

My thanks to all those who helped in research for this report including the following individuals.

Joanne Anderson, Curatorial Assistant, Great North Museum, Tyne and Wear Museums

John Cahalane, Sothebys, London

Jon Campbell, Head of Visitor Services and Security, National Gallery, London

Andy Chadbourne, Intellident, Stockport

Karen Clarke, Museum Registrar, Hampshire County Museums

Terry Coonan, Sales Manager, Northern Apex, Fort Wayne, Indiana

Jeff Cowton, MODES Users Association

Nick Crofts, Nicholas Crofts Consulting

Dylan Edgar, ICT Development Officer, London Museums Hub

Roger Fischer, Kaywa AG, Zurich

Juliette Fritsch, Head of Gallery Interpretation, Evaluation and Resources, Victoria and Albert Museum, London

Stephen Glynn, Head of Gallery Services, Momart Ltd, London

James Goodland, Intellident, Stockport

Oliver Green, Head Curator, London Transport Museum

Rob Green, Managing Director, ISIS Ltd, London

Elmar Groen, Coordinator Conservation and Management, Gemeentemuseum, The Hague

Martin Grimes, Web Manager, Manchester City Galleries

Forbes Hawkins, Collections Systems Developer, Museum Victoria, Melbourne

Kathy Harman, Information Management and ICT Manager, Community Services Department, Leicestershire County Council

Simon Harper, Lecturer in the Information Management Group, School of Computer Science, The University of Manchester

Martin Harrison-Putnam, Senior Curator - Collections Management, London Transport Museum

Matt Haworth, Web Professional, Manchester

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Graham Higley, Head of Library & Information Services, The Natural History Museum, London

Wouter Hijnberg, Helicon Conservation Support bv, Alphen aan den Rijn

Tadashi Hisanaga, Hitachi America Ltd

James Hodgkin, Library Services Manager, Natural History Museum, London

John Hodgson, Keeper of Manuscripts and Archives, The John Rylands University Library, The University of Manchester

Adrian Holloway, Collections Manager, Horniman Museum, London

Norbert Kanter, Director, Zetcom, Berlin

Suzanne Keene, Reader in Museum Studies, University College London

Joseph King, Walker Art Center, Minneapolis/WashiWrap LLC

Ken Lee, Chief Technical Officer, CBS Technology Berhad, Kuala Lumpur

Gordon McKenna, Standards and Systems Manager, MDA, Cambridge

Steve McLean, Project Director, Great North Museum, Newcastle

Lynne McNairn, Systems Administrator, Collection Information System, the Powerhouse Museum, Sydney

Norman Marengo, Fraunhofer Institute for Silicon Technology ISIT, Itzehoe

Fiona Marshall, Knowledge Development Manager, MLA East Midlands, Leicester

Liz Mitchell, Senior Manager: Online Gallery, Manchester City Galleries

Jonathan Morgan, Managing Director, Hypertag, Cambridge

Bartek Muszynski, President, NJE Consulting Inc, Richmond, British Columbia

Ruth Neave, Collections Management Officer, McManus Galleries & Museum, Dundee

Jennifer Noffze, Registrar/Archivist, The Children's Museum of Indianapolis

Zawawi Itam Osman, Registrar, National Museum, Kuala Lumpur

Chris Powell, ICT Officer, The Ashmolean Museum of Art, Oxford

Ivor Pridden, Project Conservator/Honorary Research Assistant, Petrie Museum, London

Caroline Reed, Development Manager, MLA London

Sharon Robinson, Collections Care Development Officer, London Museums Hub

Ananda Rutherford, Assistant Keeper, Collections Manager, Geffrye Museum

Will Real, Director of Technology Initiatives, Carnegie Museums of Pittsburgh

Trevor Reynolds, Collections Registrar, English Heritage, London

Ian Rowson, General Manager, ADLIB Information Systems, Swindon

Reviewing Machine-readable Systems by Julian Tomlin - Final Report

Christian Rümelin, Assistant Keeper, Western Art, The Ashmolean Museum of Art, Oxford

David Scruton, Documentation and Access Manager, Fitzwilliam Museum, Cambridge

Gayle Silverman, Director of Client Services, Willoughby Associates, Limited, Winnetka, Illinois

Mike Stapleton, Technical Director, System Simulation Ltd, London

Ben Sullivan, General Manager Europe, KE Software, Manchester

Martin Swerdlow, OATSystems, London

Sandra Tatsakis, Museum Boijmans Van Beuningen, Rotterdam

Jaap van der Burg, Helicon Conservation Support bv, Alphen aan den Rijn

Martin Warren, Collections and Information Manager, Norfolk Museums and Archives Service

Helena Wetterberg, Community Interpretation Officer, Manchester City Galleries

Peter Winsor, Collections Link

## Appendix D: Images

### Technological Overview



AUD14  
NWHCM : 1891.52 : F  
Norwich Cathedral  
Sewell, Benjamin

1. A Code 39 barcode generated for audit purposes at Norfolk, showing the barcode number and object description. Copyright: Norfolk Museums and Archives Service



2. QR code used in Revealing Histories pilot at Manchester Art Gallery.



3. Illustration showing the use of a Quick Response code, using Kaywa Reader software on a mobile phone. Copyright: Kaywa AG



4. An RFID tag with an adhesive backing. The transponder can be seen as a dot in the middle, while the outer circuit is the antenna. Copyright: Intellident Ltd

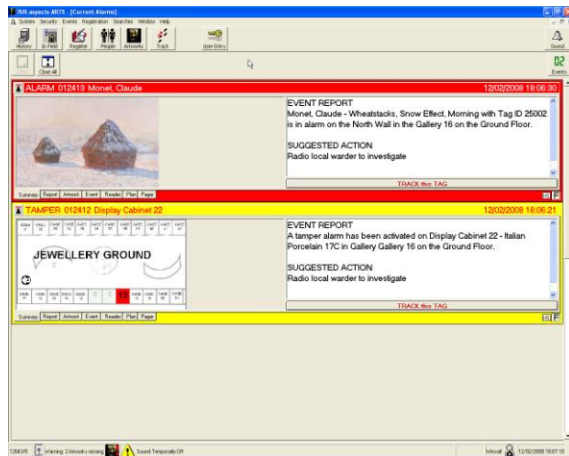


5. RFID tags as supplied on a roll from Washi Wrap. Copyright: Washi Wrap™ LLC



6. RFID reader Copyright: Washi Wrap™ LLC

Review



7. Screenshot from ISIS software showing alarm events. Copyright: ISIS Limited

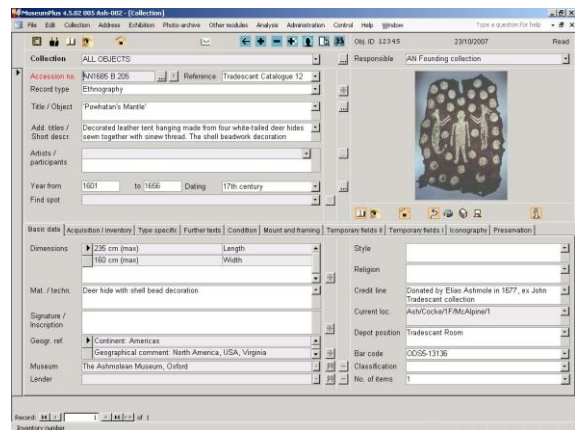


8. The TechTag at the Tech Museum activating an RFID reader embedded in the worktop. Copyright: Hitachi America Ltd

Case Study 1 – Ashmolean Museum



9. Data station at the Ashmolean, showing the notebook computer, barcode scanner and photographic stand. Copyright: Ashmolean Museum, University of Oxford



10. Screenshot of MuseumPlus software with object barcode id in lower right corner. Copyright: Ashmolean Museum, University of Oxford

**Case Study 2 – The Children’s Museum of Indianapolis**



11. Encapsulated RFID tag from Washi Wrap as used at the Walker Art Center, Minneapolis. Copyright: Washi Wrap™ LLC



12. Object with tie-on tag, showing RFID tag. Copyright: Children’s Museum of Indianapolis



13. Tray with PocketPC running ARTifact TRAC software, RFID tags, and fixed and portable RFID reader/writers. Copyright: Children’s Museum of Indianapolis

**Case study 3 – Fitzwilliam Museum**



14. Magus guide in use at the Fitzwilliam Museum. Copyright: The Fitzwilliam Museum. Photography: Stephen Bond



15. Mockup of Magus guide. Please note PDA and icon different to those used. Copyright: The Fitzwilliam Museum. Photography: Stephen Bond

Case study 4 – Gemeentemuseum



16. Barcode on tie-on label at the Gemeentemuseum. Copyright: Julian Tomlin

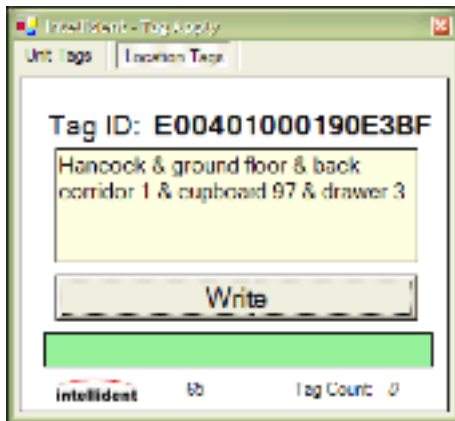


18. Coin size tag attached directly to glass jar Helicon Conservation Support. Copyright: Julian Tomlin

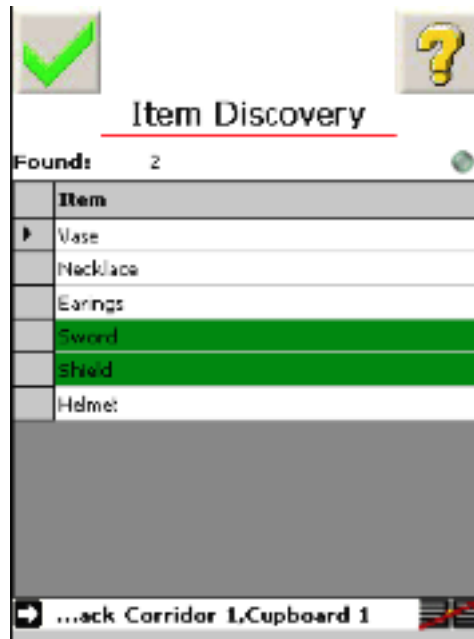


17. Encapsulated tag attached to underside of table at Helicon Conservation Support. Copyright: Julian Tomlin

Case Study 5 - Great North Museum



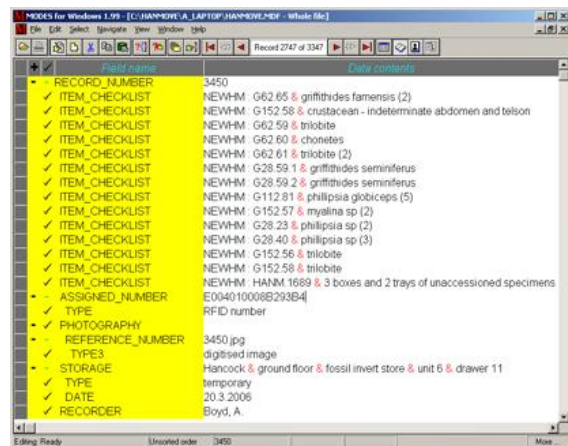
19. Writing the location information to the RFID tag using Tag Apply software. Copyright: Great North Museum



21. Identifying objects at a location using the hand-held reader. Copyright: Great North Museum



20. Updating locations for objects using the hand-held RFID reader. Copyright: Great North Museum

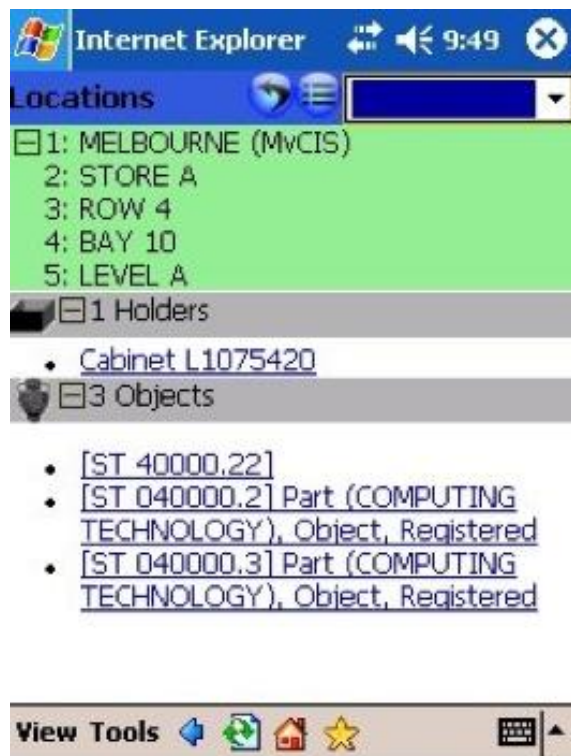


22. MODES record of storage unit showing contents. Copyright: Great North Museum

Case Study 6 – MVWISE



23. Screenshot of MVWISE Home page running through Microsoft Internet Explorer on a PDA  
Copyright: Museum Victoria



24. Screenshot of MVWISE locations page showing containers and objects. Copyright: Museum Victoria

Case Study 7 – Manchester City Galleries



24. Manchester Ship Canal Cruet and Stand with object label, visitor comment and QR code.



26. QR code for above exhibit.

Bonbonniere



This bonbonniere was used as a storage box for sugar coated mints, and was made around 1770 in Staffordshire. It's on display in the gallery atrium on the Ground Floor.

Tell us what you think

My thoughts are:

Submit

Other links

- [Tino Tamsho-Thomas' Poem MP3/ACC/Text](#)
- [Curator's Intepretation MP3/ACC/Text](#)
- [Mike Leng's Intepretation MP3/ACC/Text](#)
- [See other objects](#)

27. Web page for mobile phone, for another exhibit, the 'Bonbonniere'.

**Case Study 10 – The Petrie Museum**



28. Crystal box and older style open box from the Petrie Museum, with barcode carrying the museum number and barcode number. Copyright: Julian Tomlin



29. Display case at the Petrie Museum, showing group of object barcodes, location barcode, and object labels. Copyright: Julian Tomlin

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