WHAT'S THIS?

THE DEVELOPMENT AND EVALUATION OF A LOCATION BASED EDUCATION ENHANCEMENT SYSTEM FOR USE WITH NETWORK CONNECTED MOBILE DEVICES AND TWO-DIMENSIONAL CODES

Research Digest for Partners

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Abstract

The use of location based services to link downloaded web information to the location of a mobile phone is becoming commonplace. However, the positional precision that can be achieved is limited in certain situations, especially where objects of interest are in close proximity. This project investigates the use of QR codes to overcome that precision problem through the development of an open source, web based delivery system that allows the simple repurposing of existing bilingual materials and their delivery, appropriately formatted, to smartphones. It also investigates whether such an exercise makes good use of resources and if the ultimate users of the system perceive benefit.

Acknowledgements

"QR code" is a registered trademark of Denso Wave Incorporated.

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Chapter 1—Introduction

Many visitor destinations in the UK and throughout the world have an educational objective as part of their remit, particularly those that fall within the scope of "heritage" destinations, museums and those that are publicly funded[1]. Traditionally this remit has been satisfied to a great extent through the use of static signs, paper based hand-outs, books and other paper products. Recent innovations also include the addition of animated displays, interactive information stations and, latterly, web sites.

The traditional paper based / signage approach suffers from a number of obvious drawbacks. Generally, the space that can be allocated to such resources is limited. Figure 1 shows the space available for interpretation for all the objects in the five shelves above in a typical display cabinet in the porcelain collection in the National Museum Wales, Cardiff[2]. Any attempt

Figure 1—Base of a typical display cabinet in the National Museum of Wales showing the space allocated for interpretation.

to increase the interpretation materials presented at the point of delivery inevitably encroaches upon the space available for the objects themselves, the items of primary interest.

Figure 2—Bilingual labelling for a single pair of objects.

This problem can be compounded significantly when more than one language is habitually in use (as in the case here in Wales). Figure 2 shows the bi-lingual label for a pair of objects—the two teapots on the bottom tier in Figure 1. The viewer is presented with the title—"Two teapots"—a paragraph

relating to their age and origin, a paragraph outlining their construction and a footnote regarding the donor. Typically the visitor is lucky to see more than a paragraph or

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[1] Throughout this paper the term "museum" or "venue" is used to encompass all visitor destinations, heritage attractions and similar venues with an educational remit.
[2] National Museum Cardiff, Cathays Park, Cardiff

two of information about any one object and in many cases not even that. There is no space for contextualising and little or nothing to take away from the experience. There is no interaction, either with the object or with fellow learners, and no opportunity for later reflection. The user experience tends to be isolated, fleeting and passive. The learning experience appears to be practically non-existent.

The "traditional" paper based work sheet provided for schools can make a difference to the experience. It allows for group work (to a degree), additional interpretation and contextualising (again publication space permitting—it's not cost effective to produce booklets with more than a few pages, especially when producing a range of booklets covering the same objects, but with different learning objectives for disparate user groups), a degree of interaction and the user has something to take away with them for later reflection. However, the experience for the user is still relatively passive and relatively solitary. In addition these resources can be quite costly to produce and keep updated, especially when there are a multitude of different stakeholder groups to be catered for.

Figure 3—Interactive workstations at St Fagans Museum

Animated and interactive displays and installations have become popular in recent times and these partially alleviate the drawbacks outlined above. However, video presentations, although multi-user, inevitably tend to be passive experiences. Interactive installations in theory are less passive (sadly with some it can be hard to tell), but will usually only cater for one user at a time. Figure 3 shows a set of four interactive workstations at St Fagans National History Museum[3]. The size of the screens and the single hand held headphone lends credence to the single user per workstation intention.

Similarly, the screen size in the adjacent video presentation area shown in Figure 4

Figure 4—Video presentation area at St Fagans Museum

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[3] St Fagans National History Museum, Cardiff

(similar to that of a domestic television) doesn't allow for more than a few users to view the presentation at any one time.

Both types of multimedia enhancement are expensive to produce in terms of the development of the resource, the hardware needed to present the resource and the space needed to display it. Once again, there is little for the average user to take away for later reflection.

1.1   In an ideal world…

The ability to place a variety of contextualising resources in a variety of formats in front of a visitor at the point of contact with *any* artefact and the ability to make those resources interactive in a meaningful way appears to be the (as yet unobtainable) goal of many museums[4]. The facility to take away materials and notes for later reflection and the ability to interact with fellow learners in real time would be the icing on the cake.

It's not as if the institutions in question don't have the information or related artefacts that could be used in this way. Indeed, a recurring sentiment expressed by a number of educational professionals connected with the establishments visited whilst surveying existing information provision was one of frustration. Frustration as to how little they could physically display compared to how much they had in their collections (and frustration regarding how little of their collections had been digitised and made accessible to a wider audience). There is no doubt that enormous strides have been made in the digitising and contextualising of collections worldwide. However it remains an on-going, slow and enormously expensive project—"The estimated total cost of digitising the collections of Europe's museums, archives and libraries, including the audio-visual material they hold is approximately €100bn" (Nick Poole, 2010) and that's excluding the additional costs of preserving and providing access to the materials after digitising. Understandably, many institutions, having started the effort, want to see the materials digitised and contextualised to date made accessible to a wider audience as soon as possible.

What's more, once digitised, overlaying a web interface offers a relatively simple way of providing access to the information[5]. Web based information (theoretically) allows for a greater degree of interaction and much more information to be presented in a

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[4] In museum circles this is known as "layering of information".
[5] Assuming that the meta-data creation, tagging, contextualising, linking and indexing of the information is done as part of the digitising process.

multitude of different formats—text, audio, video, stills, multi-lingually— and cost effectively.

So (anecdotally) it would appear that many venues with educational remits already have considerably more information available on line—or at the very least in electronic format—than they can hope to present "on the shop floor". The major problem, more often than not, is that this related information isn't available when and where it's needed, at the location of the physical artefact on display at the time the visitor is standing in front of it.

Generally speaking it's not practical to have traditional computer terminal style web access points close to every location or artefact of interest for all the same reasons outlined earlier (space, capital costs and multi-usability). Obviously users could access the information either prior to their physical site visit or after the fact, but there is little evidence that such interaction is taking place (anecdotally it would appear that it is not). What's more, the immediacy of the experience with the physical artefact/location is destroyed.

How can museums overcome this problem without throwing enormous sums of money at it, money that, in this era of cutbacks, they don't have? How can they "leverage" their assets?

Chapter 2—Smartphones—a possible solution?

One (perhaps obvious) solution to the problem of lack of physical space for web enabled computers is to use small, portable network enabled devices instead, PDA's for instance. Such an approach does still have its drawbacks, especially if the devices are provided by the venue. Unwanted layers of complexity are added to the management of the user experience (managing the distribution and collection of the devices, their maintenance and of course the capital cost to name but a few). In addition there is (potentially) a degree of re-formatting required to display the original digitised material on a small screen.

Putting to one side the re-formatting problem for now, we can take this idea one stage further and consider an alternative to portable devices supplied by the venue and contemplate the use of visitors own smartphones[6] instead. Immediately many of the management problems go away. There are no distribution and collection requirements, no capital costs and the maintenance is the responsibility of the phones owner, the visitor.

2.1   Smartphone nirvana

Assuming that smartphones are deemed to be suitable a number of new interconnected considerations need to be taken into account. In particular:

- How many visitors have phones that are "smart" enough?
- How should the phones be connected to the network to access the related information?
- Which is the more suitable method of providing a positive user experience? A dedicated "App" or something else?
- How can the smartphones be made to be location or artefact aware and deliver information appropriate for the current context?

Starting with the question of how many visitors have suitable phones. Many commentators agree that the use of smartphones is on the increase. What they disagree upon is the extent of current adoption and the rate of increase. The

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[6] There are many definitions of what is or is not a smart phone. Most incorporate the concept of having a cellular phone with internet access and built in applications. Beyond that common ground, definitions can differ widely and include many attributes of personal computer style functionality . For instance "Smartphones provide digital voice service as well as text messaging, e-mail, Web browsing, still and video cameras, MP3 player, video viewing and often video calling. "(PC Mag encyclopedia: Definition of: Smartphone, n.d.). In the context of this paper we will be adopting a relatively basic definition of a smartphone as one that has cellular phone access, data connectivity via the cellular network and/or through wireless connectivity, web browsing capabilities, multimedia capabilities, and a camera.

Olswang convergence survey report for 2011—based upon a survey undertaken by YouGov of more than 2000 UK adult consumers—indicates that 36% of those surveyed had an iPhone or other smartphone and an additional 16%[7] intended to upgrade or buy one in 2011 (Phillips and Enser, 2011).

The question of how to deliver the location aware information cannot be considered in isolation from the question of the network connectivity and the user interface. There are, broadly speaking, three main techniques for pinpointing the position of a cell phone.

- Cell Tower Triangulation
- GPS
- (Manually) entering a location
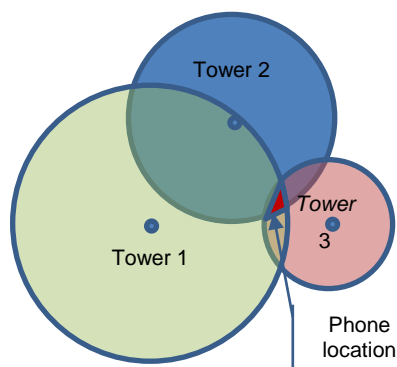
Figure 5—Cell tower triangulation

Cell tower triangulation depends upon the phones signal being picked-up by one or more cell phone towers and a distance calculation to each of those towers based upon ping times between the phone and the towers. The accuracy of position depends greatly on the number of towers in range and can be affected by factors such as signal reflections off tall buildings. Accuracies are typically in the order of 100 plus meters (Chen et al., 2006).

Many modern smartphones have location functionality built in in the form of GPS chipsets, the use of which is becoming commonplace, and many apps developed for smartphones are designed specifically to use this positional data. However, time to get an initial position can be significant ("from several seconds to minutes" (von Watzdorf and Michahelles, 2010)) and positional accuracy still leaves a lot to be desired ("GPS allows for an accuracy location up to 5 to 10 meters" (von Watzdorf and Michahelles, 2010) even when using assisted[8] GPS. What's more, signal strength is greatly attenuated when the satellites are not visible (when inside a building for instance or even when "shaded" by tall buildings in an urban environment). Finally, not all of the current generation of mobile operating systems

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[7] The report separated data for iPhones from other smartphones. What was not made clear was how many of the respondents were going to "upgrade" from one smartphone type to another smartphone. So the true figure after upgrades is likely to be between 36% and 52%. Nor was the definition of "smartphone" explicitly stated.
[8] Assisted GPS: GPS used along with additional factors to either speed up the initial satellite fix or add additional positional information (such as cell tower triangulation) to increase the accuracy of the calculated position.

and associated browsers support the W3C Geolocation API that allows access to the positional information provided by the phone in the web browser.

Given that:

a) much of the envisaged use of any system developed for this environment will be indoors,

b) geolocation information relating to the position items on display is not commonly collected and stored, and

c) many items will too close together to be consider as being in separate locations by the two technologies outlined above

we can disregard both cell tower triangulation and GPS as being too inaccurate leaving us with "entering a location" and the only practical method of identifying an objects location and linking it to any form of data retrieval and display system. A moments thought, however, leads to the conclusion that the absolute location of an artefact isn't particularly important. It's the identity of the artefact that we need. So rather than "entering a location" we need to "enter the unique identifier".

Before taking the artefact identifier aspect further we need to take a step back and consider the other facets of the smartphone solution, in particular the user experience and how the network connectivity and user interface impact on it. Broadly speaking we have two choices for a user interface, an "app"[9] or a mobile web browser, and two choices for network connectivity, WiFi or Cellular Data Network (CDN).

Starting with the question of user interface. When compared to a web browser interface, a dedicated app could (potentially) allow a significantly enhanced experience for the user, with features such as audio notes and in-app video to name but two. However, if we go down the app path, there is a significant programming overhead, especially if we need to cater for all the popular smartphone platforms.

On the other hand, if a web browser interface is used, although it's limited in some respects (for instance at the time of writing it is not currently possible to directly integrate audio recorded from the phones microphone for note take purposes), and there is still programming involved, it does allow the museum to develop a single solution that is accessible on all web enabled phones in one fell swoop—develop

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[9] A standalone application designed to run on a mobile phone.

once deliver to many. In addition, there is no app to download[10] and all updates and enhancements that may be produced after the launch are server-side so no upgrades need to be downloaded either. It would appear that the browser option may be superior one at present.

As far as the network connectivity is concerned the two options—WiFi and CDN—are not mutually exclusive. Many smart phones can be configured to try and connect to any WiFi network within range followed by attempts to connect to the fastest CDN source available (this appears to be the default option on all the smartphones tried as part of this investigation). Obviously, WiFi access generally provides the better (faster) experience and some venues provide free Wi-Fi access (or have partnerships with third party providers such as BT Openzone that provide free—bundled with a phone contract—or "small fee per day" access). Cellular data network coverage in the UK commonly comes in a number of "flavours" including UMTS/EV-DO (3G— fastest data throughput), EDGE and GPRS/1xRTT (slowest data throughput). 3G coverage is patchy throughout the UK, but is generally reasonable in urban areas. Unfortunately some visitor destinations that might find this proposed system useful are outside the urban envelope and are poorly served by the cellular data network. Given that some of the data we intend to deliver to the smartphones is bandwidth heavy even when optimised for mobiles (video clips for instance) then, in the absence of WiFi connectivity, the use of smartphones in these areas of poor CDN coverage is probably not practical.

However, all is not lost. If the venue is well served by conventional land-line (or satellite) broadband then setting up a walled garden[11] wireless network is relatively simple and (comparatively) cheap[12]. Even if the venue is completely off the map as far as internet access is concerned there are possible solutions. Setting up a small web server serving pages to a closed wireless network with no external access is, if not trivial, relatively easy to achieve and once again comparatively cheap.

2.2   Web is the way to go

Having settled upon smartphones using WiFi/CDN network access and a web browser as the user interface there now only remain the questions of how to link the

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[10] All smartphones surveyed to date have pre-installed web browsers.
[11] Walled garden: net access is restricted to a whitelist of acceptable web sites and internet services.
[12] The design and implementation of such a wireless network is beyond the scope of this paper. Suffice to say a professional quality access point with power over Ethernet (PoE) such as the Cisco Aironet 1130AG typically costs at the time of writing approximately £200 (ex VAT).

artefact being viewed with the data to be pulled in and how to optimise the data for transmission over a (potentially) relatively slow network. The priorities here are:

- Ease of use—minimise user keying and, as far as possible, keep the experience self-contained within a single window
- Maximise data throughput—avoid waiting time
- Maximise interactivity—allow the user to make choices and become involved with the materials

Throughput is dependent upon the network environment and, to an extent, upon the interface design and presentation of the data. Strategies such as optimising the compression of the data prior to transmission and providing the user with choices upon receipt (clickable thumbnails of large pictures for instance) will all go some way towards ameliorating the negative aspects of potentially poor network performance. Theoretically it might also be possible to provide a user with the option to choose between high bandwidth and low bandwidth versions of the information offering.

Interactivity is dependent upon well thought-out user experience design and the availability of suitable content/materials to stimulate the interactivity in the first place. One particular benefit of the web based approach is that an initial, rapidly implemented, partially interactive version of the proposed system can very easily be "upgraded" incrementally by changing the server code as and when new content becomes available without requiring the users to "update" anything.

As far as ease of use is concerned, theoretically it is possible to have an app that would allow a user to point their phones camera at an artefact, scan it and have the system recognise it and load the associated information. Google Goggles[13] uses this type of image recognition as does the Artfinder fine art image recognition app[14] and Layar Vision[15]. However, this type of image/object recognition isn't easy to implement (especially for three dimensional objects) and requires the type of server side resources that we don't have access to. It also requires that the server is primed with appropriate images of the artefacts were interested in and these may not always be extant. The object of the exercise here is to provide a method of using *existing* information with minimal effort, not create a whole load of new digitising

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[13] http://www.google.com/mobile/goggles/
[14] See http://vimeo.com/25763379 and http://itunes.apple.com/us/app/twombly-poussin-arcadian-painters/id444937533?mt=8&ls=1
[15] http://www.layar.com

tasks that must be completed before a single artefact can be linked to its associated data. In addition we have already discounted the use of a dedicated app so this type of image recognition doesn't suit our purposes. What we need is some form of token that will link the artefact to a web page showing related information. Obviously, displaying a URL[16] and letting the user type it in is one answer. However, this doesn't satisfy our ease of use criterion, especially on smart phones that use cut-down keyboards with predictive text. In the authors experience such systems rarely cope well with URLs. Shortening the URL using one of the widely available shortening services and displaying the truncated URL would make things a little easier but it would still be a fiddly process typing in the address (especially as such services often mix upper and lower case characters and numbers as part of their identifier). Displaying a number and allowing the user to type it into a field on a pre-loaded web page would be even easier, but it requires that the web browser is started somehow with the required form displayed and mis-keying is still a very real possibility. What we need is a contactless, keyless method of inputting the URL and firing up a web browser onto the right page in one fell swoop.

There are a number of potential candidates for this role.

RFID[17] tags have been used relatively successfully for a similar scenario (Liu et al., 2007). RFID tags fall into two broad categories, passive—the scanning device supplies the energy that enables the transfer of information—and active—the tag itself has a power source that enables the transmission of information. The tags can be hidden out of sight and passive tags can typically be 1 to 3 meters from the scanning device (Dresssen, 2004). However, generic RFID scanning doesn't appear to be widely supported in smartphone handsets and those that do require specialist apps in order to take advantage of it. Although an RFID tag could contain a URL—typically the data capacity is sufficient—apps to scan a tag and load a web page appear to be particularly scarce[18]. In addition, the relatively long ranges involved could lead to the same sort of artefact separation problems outlined above for GPS positioning. There are also potential security issues with the unlikely, but possible hidden placement of a malicious tag leading to a rogue web site.

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[16] URL—Uniform Resource Locator, a string identifying where a resource can be found on the Internet.
[17] RFID— Radio-frequency identification.
[18] At the time of writing the author was unable to locate any such apps.

NFC[19] (a short-range subset of RFID with ranges in the order of 20 centimetres or less) would solve the separation and security problems and it is supported in an increasing number of smartphone handsets[20]. However, there are still too few handsets on the market with this feature to make it a viable contender in this context. Also, although there are more apps available for NFC scanning than for RFID, it would appear that these are currently not widely used[21]. What's more, it could be argued that the short range of this device is a disadvantage in this context. Users need to place their handset right next to the scanning point which inevitably means that only one person can scan at a time.

Visible (optical) tags would appear to overcome most of the problems associated with RFID/NFC tags. With sufficient forethought regarding their placement many users can scan such a tag simultaneously, and most smartphone handsets have the ability to scan them. What's more they are cheap and easy to produce. All you need is a printer and appropriate (freely available) software. Some of these codes permit the encoding of data in such a way so as to allow the type of data to be recognised for what it is. A phone number can be recognised as such and appropriate actions initiated; so too SMS links and (of particular interest to us) web URLs.

And that's where two dimensional codes, and in particular QR codes[22], come in.

2.3 QR Code Features
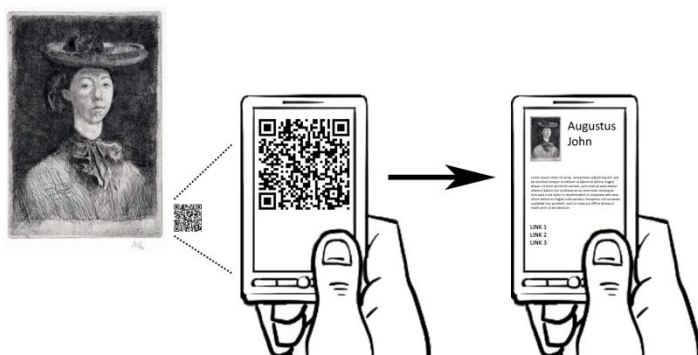
Figure 6—Possible application of QR codes

QR[23] codes are essentially a compact method of encoding information—including alpha numeric text, numbers, binary data and Kanji—which can be decoded relatively easily with a scanning device. Mobile phones with cameras and appropriate, widely available, freely downloadable software can be used as scanning devices. What's more, if the information contained within the QR code consists of a URL,

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[19] NFC—Near field communication.
[20] NFC is a key component in proposed contactless payment systems using mobile phones and many manufactures are now adding NFC chipsets to their "standard" set of components for new phones.
[21] A short survey of applications on the Andriod Market web page— https://market.android.com/—shows for instance, with a few exceptions, downloads for apps tagged with "NFC" are in the tens or hundreds at most.
[22] The phrase "QR Code" is a registered trademark of Denso Wave Incorporated.
[23] QR code is popularly described as an abbreviation for "Quick Response code" although some commentators—such as (Hsiao et al., 2010)—also expand it to be "Quadratic Residue code".

many of these decoding applications can automatically (or semi-automatically, requiring a simple "accept" action from the user) open a browser on a smart-phone, connect to the Internet, and display the relevant web page. Thus the placement of a QR code adjacent to a point of interest can initiate a link directly to relevant information as shown in Figure 6. Such a placement allows us to anchor the focus of our attention in space and time.

QR codes were developed by Denso Wave Incorporated in 1994 (QR Code.com, 2000) and became an ISO standard—ISO/IEC18004) in June 2000 (QR Code.com, 2000). Although Denso Wave holds the patent for QR codes they have chosen not to exercise it, in effect making the QR code specification open and allowing use without the payment of a licence fee[24].

Figure 7—Typical version 2 QR code (this one encodes the text "This is a QR Code")

QR codes encode information both horizontally and vertically (as opposed to the horizontal coding used in the commonly encountered bar code). Hence their classification as two dimensional (2D) codes. This second dimension allows for an order of magnitude more information to be encoded in a similar space. "While conventional bar codes are capable of storing a maximum of approximately 20 digits, QR Code is capable of handling several dozen to several hundred times more information" (QR Code.com, 2000). The information capacity of a standard QR code depends upon the version in use and the error correction level. Versions range from version 1—21 modules (squares) by 21 modules—through to version 40—177 modules by 177 modules. Error correction capability (ECC) ranges from Level L—approximately 7% of the code can be damaged and the code can still be read—through to Level H—approximately 30% correction capability. This gives us a capacities ranging from 72 data bits (for the smallest QR code version—version 1—with the maximum ECC level) through to 23,648 data bits (for the largest QR code version—version 40—with the minimum ECC level) (QR Code.com, 2000). Micro QR codes also exist with even smaller sizes and smaller information carrying capacity.

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[24] It should be noted, however, that Denso Wave *do* require that an acknowledgement be posted when their trademark phrase "QR Code" is used. In addition there has been some discussion re the validity of patents held by third parties relating to the actual process of scanning URLs in codes and linking to web pages as a result (Barkume & Associates, P.C., 2009). At the time of writing it would appear that this *doesn't* affect the use of URLs in QR codes in the context proposed here because the scanning device retrieves the URL from the printed code and not through a lookup on a remote server.

An additional advantage in this proposed scenario is that they can be relatively small (when compared to other forms of signage in a museum context)[25], are resistant to dirt and damage (they have built in error correction) and can be read in any direction.

Given that we have already stipulated that we wish to use a web interface our ideal scenario would be to initiate a web session at the beginning of a visit and then proceed to initiate further QR code scans from within that web browser session each time a new object and associated code is encountered. It turns out that this is not a simple as one might hope, especially when considering cross platform applications. In fact, at the time of writing it appears that this is not possible on any platform, or to be more exact, not possible using mobile web browser functionality and nothing else. In certain cases it is possible to use a separate local QR code scanning application as a "helper" application, a call from within the browser causing the local app to launch and simplifying the user experience to an extent. However, even this is only possible on certain Android phones, and even then only when a particular scanner application is loaded. Whilst it is true to say that, using a web browser interface, it is possible to serve different content to different platforms, it is not possible to detect if a particular app is installed. So the concept of building a version of the web applications solely to cater for this particular scenario was thought to be too niche and impractical in this instance.

The probable usage cycle could be as shown in Figure 8[26].

Strictly speaking this usage cycle breaks the "no app" rule discussed earlier. However, it was decided that, because the apps to scan QR codes are so widely available for all the popular smartphone platforms and because the use of such apps to launch web pages was so simple as to require little or no user training, this minor infringement outweighed the requirement
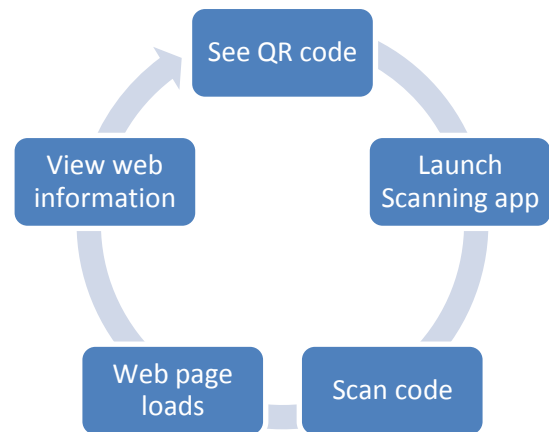
Figure 8—QR code to web information process

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[25] Optimum size is dependent upon the dot-pitch of the printer used to produce them—the specification recommends a minimum module width of four dots—and the resolving capabilities of the device used to scan them. As a general rule, to aid scanning from a distance and to maximise clarity, it is recommended that the code be printed as large as possible in the space available. Typical codes in this context might be anything from $5cm^2$ to $10cm^2$.

[26] In some cases, once the scanning app has been loaded, users can "flip" between the web browser and the scanning app without the need to repeatedly launch the app. In this way one step is removed from the cycle after the first iteration.

for a separate app[27]. In addition when API and browser standard updates are fully implemented across mobile platforms and browsers, future versions of a web browser based tool to scan QR codes directly from the browser should become possible[28] doing away with the need for a separate app. At the very least location information from the mobile device will be accessible (most devices actually support this already)[29].

So why use QR codes in particular? There are other coding schemas in everyday use including (but not limited to) JAGTAGs, SnapTags, MS Tags (Microsoft™ Tags), BeeTaggs, EZcodes, and DataMatrix Codes. Why not use one of those?

QR codes were selected in particular for this project for a number of reasons. Firstly, the standard is open (and ISO approved) and there are many free tools for generating codes and tracking their use (for example goo.gl, the Google URL shortening tool can also generate QR codes and provide basic tracking—more on this tool later).

Secondly, although QR codes can contain any digital data, the sensible and widespread use of appropriate prefixes such as "http://" or "mailto:" or "sms:" to classify encoded data types[30] means that most QR decoding tools can be programmed to initiate the appropriate action (opening the web browser and launching a web page for instance) automatically or semi-automatically (zxing project, 2010). Commonly handled data types include:

- Text
- Website URL
- Telephone Number
- SMS Message
- Email Address
- Email Message
- Contact Details (VCARD)
- Event (VCALENDAR)
- Google Maps Location
- Wifi Login (Android Only)
- Paypal Buy Now Link

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[27] Some more modern smartphones allow for multiple applications to be running at the same time so once the scanning app has been loaded the first time the user simply has to "flip" between running applications rather than reload it for each scan making the process even simpler.

[28] The Media capture API, when fully implemented, should allow direct access to a camera from within the web browser opening up the possibility of java initiated scanning directly from within the browser session. See (Tran, Oksanen and Kliche, 2010)

[29] An alternative approach is that taken by some app developers which is to build a browser into the QR code scanner. Either way the user ends up using a single app interface.

[30] These data type prefixes are mostly not official standards, rather they have become de facto standards through widespread use.

- Social Media
- iTunes Link
- YouTube Video

QR codes are also particularly well suited for unusual placements. They can be scanned from any angle (even from behind which theoretically makes them suitable for display on transparent surfaces), are resistant to distortion (which makes them suitable for placement on surfaces that aren't perfectly flat) and have built in error correction (at selectable levels or redundancy) which means that they can still be read even when up to 30% of the code is damaged (Soon, 2008).

They can be almost any size from millimetres across to codes the size of a building (or even larger[31]). In this context it means that scaling up a code to allow it to be scanned from a distance is quite acceptable.

They are generally monochrome (although colour is an option—it's the contrast between the modules and the background that's important) and as such cheap and easy to produce.

The data in question (in our case web addresses) is actually encoded within the QR code as opposed to some scanning technologies where a reference is encoded that requires a round trip to the server in order to translate it into a redirect to the desired web destination.

They are proven technology, both on mobile and non-mobile devices, and can be read by readily available consumer mobile devices. (Horwood, 2008).

The final, and perhaps the most compelling, reason for opting for QR codes is that they appear to have achieved the best penetration of all the 2D code formats with significant numbers of smartphone users already having the necessary scanner app installed[32]. Of the 42% of respondents to a recent marketing survey who agreed that they were familiar with QR codes, 61% said they had scanned one before (Lab42, 2011).

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[31] http://hello.w0r1d.net/ shows a visual 2 dimensional code (in this case a semacode which has similar properties to a QR code) in a field that theoretically can be seen from space.
[32] A simple survey of the downloaded apps tagged QR code from the Android Market place shows download figures of some popular aps being the tens of thousands if not hundreds of thousands (c.f. the NFC download figures mentioned earlier).
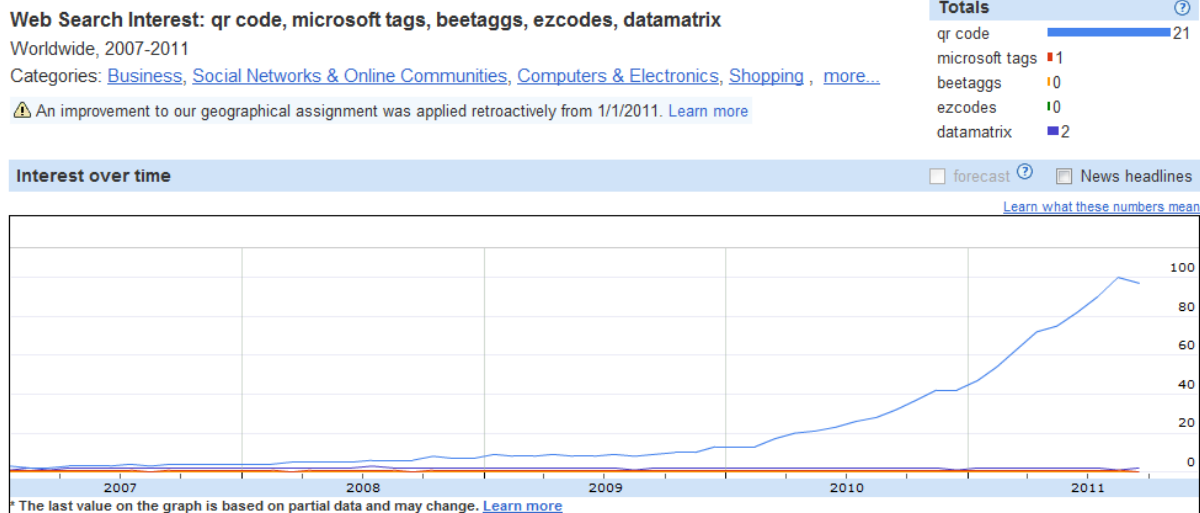
Figure 9—Web search interest for terms associated with 2D codes—Worldwide

Using Google Insights for Search to compare interest on the web[33] for the tags as search terms we can see the QR codes are certainly the most searched for term, leaving the "opposition" way behind. Figure 9 shows a comparison of terms in a world-wide context. Figure 10 shows the same search in a UK context.
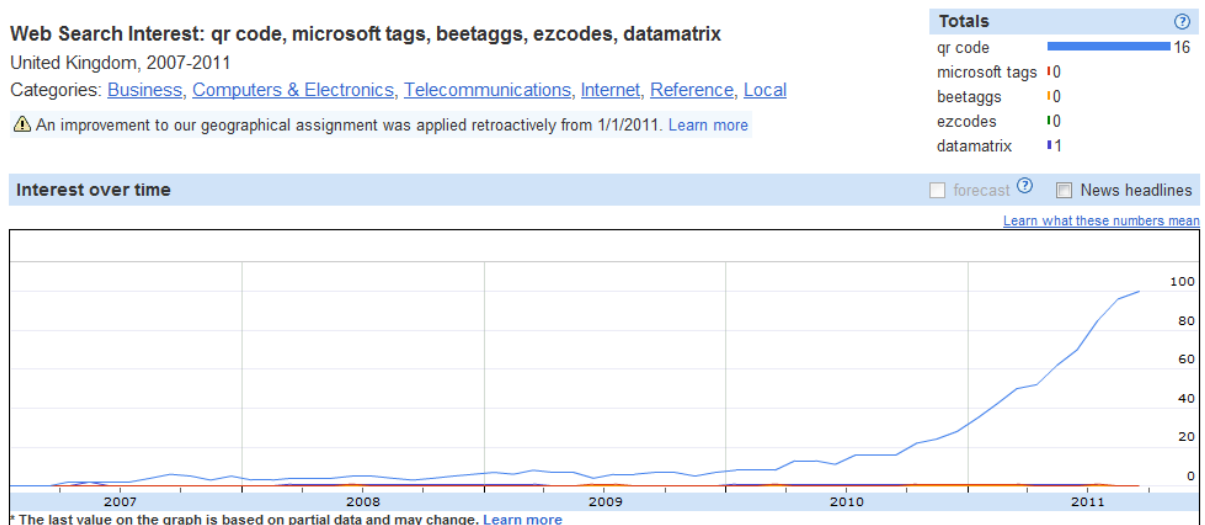
Figure 10—Web search interest for terms associated with 2D codes—UK

2.4   Why aren't QR codes ubiquitous?

If the benefits of presenting information to visitors/learners in this way are so overwhelming and if QR code penetration is so good the question has to be has to be asked "Why Aren't QR codes in common usage in such institutions?" QR codes have been around for a while, as have smart phones so we should be seeing people scanning everywhere we look.

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[33] This is a simplistic measure but it would seem logical to assume that any person planning to adopt a particular technology would at least do some web based research first.

Part of the answer is probably due to the fact that these codes are still a relatively new phenomena (at least as far as the UK is concerned—in other parts of the world, such as Japan, they have been in common usage for a lot longer). Figure 10 above lends credence to this theory showing web interest only starting to take off in 2010.

It should be noted that some museums have started to use QR codes (the earliest references I've found to date relate to projects as early as 2009[34]), but generally on a pilot or experimental basis.

However I believe that the more significant reasons are down to perception, and misconception on the part of decision makers in the institutions. When I was approaching museums and visitor attractions with a view to placing my pilot projects with them common responses in discussions about why similar systems weren't in place already included:

- "I thought QR codes were for marketing/advertising"
- "We can't afford to / we haven't got the resources"
- "How do we know people will use it?"
- "Isn't that just for kids/teenagers?"
- "Where's the evidence base?"

There appears to be little academic research focused on this area of interest (as discussed later in the literature review). There *is* research relating to the use of QR codes (some of which is quoted in this paper) but much of this tends to be directed towards proving/disproving the efficacy of QR codes in a marketing and advertising context.

2.5   Questions addressed, Objectives and Deliverables

I intend to answer three main questions.

1. How easy (or difficult) it is to develop a web based educational resource for delivery on mobile platforms, triggered by location specific QR codes, using as far as possible existing content provided by a third party?
2. How do users interact with such a resource and do they perceive a benefit?
3. Does the take up of such a resource justify the cost/time/effort involved?

As this project involves the active involvement of third parties there will be additional Aims and Objectives based around their specific requirements.

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[34] For example, the Powerhouse Museum in Sydney— http://www.powerhousemuseum.com/dmsblog/index.php/2009/03/05/qr-codes-in-the-museum-problems-and-opportunities-with-extended-object-labels/

Project Objectives:

1. Establish a relationship with a venue with an educational remit.
2. Develop a web resource, primarily for delivery on mobile platforms using as far as possible existing content provided by the venue.
3. Develop a survey/research methodology to answer the questions posed above which will also allow the third parties involved to achieve their aims and objectives.
4. Provide an overview of the process / good practice recommendations for future scaled up educational resources involving similar technology.

The key deliverables are:

- A taster site to be used to recruit a project partner(s)
- One or more pilot education resources with:
    o Agreed specification and content
    o CMS managed and CSS styled (for mobile delivery) web site
- Pre pilot baseline assessment of information provision at the pilot venues.
- QR Code signs of an appropriate size along with non-invasive, non-destructive display mounts (free standing signs for instance).
- Survey site (it is intended that most surveying will done on-line).
- Preliminary analysis and report for project partners.
- Detailed MSc thesis delivered to the University of Glamorgan.

The following chapters delve into the current research in the field of QR codes in an educational context (Chapter 3—Literature Review), the methodology adopted (Chapter 4—Methodology), the implementation of that methodology (Chapter 5—Implementation), the data analysis of the gathered information (Chapter 6—Data analysis) , directions for future research (Chapter 7—Future Directions) and the conclusions (Chapter 8—Conclusions). Finally, the appendices provide information relating to the surveys (questions and raw data) and related information such as gate information provided by the venues and the data protection policies employed.

Chapter 3—Literature review

An initial, albeit brief, survey of QR codes in use in an educational context at the beginning of this project led the researcher to the conclusion that, although QR codes and similar location based services were in use in an educational environment, they tended to be used as technological replacements for existing simpler methodologies which perhaps showed a lack of understanding of their potential. For instance, displaying a QR code in a lecture linking to resources that already exist in a well-publicised location on a VLE is perhaps not a particularly well thought through use of the technology[35]. On the other hand, displaying a code on the last slide of a presentation that leads to a guest lecturer's contact information would be considered to be a good use of the technology by many. Other uses encountered included location aware campus services (Asif and Krogstie, 2011), use as barcode alternatives for student management systems and as an add on to the results of library searches[36].

Although these were innovative uses and despite the fact that it is becoming widely recognised that "…QR codes have great potential in education" (Law and So, 2010), it appeared to the author that these applications missed a fundamental aspect of the use of QR codes to tag items. Specifically that potentially

<p style="text-align:center">A QR Code = An anchor in time and space</p>

3.1   Zeitgeist?

Mobiles have been available for use as educational tools for a relatively long time (in technological time terms) evolving from SMS and email connectors through to two way communication channels interfacing directly into the VLE. However, despite the almost ubiquitous presence of the mobile phone in every student's pocket, m-learning doesn't appear to have taken off in the way that many commentators were predicting back in the early part of this century. Meawad and Stubbs encapsulated the problem back in 2006—"The challenge facing the actual development of mobile learning lies in overcoming the limitations of mobile devices and wireless communication technologies" (Meawad and Stubbs, 2006)

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[35] Although it could be argued that any increase in the choices of information channels offered to a student is bound to be a good thing.
[36] Bath University provide a QR code as part of the individual book records accessed through catalogue searches. The code transfers the Title, Author and Classmark of the book to the users phone to act as an aid memoir when searching for the book on the shelves (the electronic equivalent of a piece of paper and pencil).

But…

…suddenly QR codes appear to be everywhere and m-learning (and in particular location based m-learning) seems to be the flavour of the month (if not year) again. Why now?

The technology has been around for a while and its potential usefulness has been recognised for many years "With the advent of location-based services and two-dimensional barcoding, for the first time many mobile devices can retrieve and deliver information based on the geographic position of the user, and on what the devices themselves can see there." (Metcalf, Brown and Rogers, 2008). Why the sudden upsurge?

The answer appears to that a number of factors that acted as barriers to the widespread adoption this technology have melted away at the same time.

"Ordinary" people are now getting smartphones "Twenty-seven per cent of UK adults now claim to own one, with 59% of our sample having bought their phone in the past year" (Ofcom, 2011) and those phones are getting large enough screens and are getting powerful enough and intuitive enough to be usable by "real" people[37]. "Web browsers, both on the desktop and the mobile device are constantly improving and, with that, the speed to process complex HTML and JavaScript rendering, delivering incredibly fast web content to user." (Power, 2011). In addition, the data capacity of the mobile network is expanding, carrying an ever increasing volume of data at ever increasing speeds—"…volume of data transferred over the UK's mobile networks increased by 67% during 2010" (Ofcom, 2011)—allowing for rich media experiences almost anywhere.

There is also an element of "Location Based Service"[38] familiarity that has crept in. People are now used to "allowing" Google to know their location and feed in location specific information to their search results. They're used to getting a Voucher Cloud coupon for the restaurant they're standing outside and, according to Rohs and Gfelle, they're used to using their mobile phone to interact with their environment "The mobile phone offers a natural way of detecting objects in the user's immediate surroundings" (Rohs and Gfeller, 2004)

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[37] As the authors wife put it.
[38] Location based Service - LBS

3.2   Location, Location, Location

So what is a Location based service (LBS) anyway? According to Ferraro and
Aktihanoglu "…LBS today is where:

- The User is able to determine their location.
- The information provided is spatially related to the user's location
- The user is offered dynamic or two-way interaction with the location" (Ferraro
  and Aktihanoglu, 2010)

Many commentators recognise the efficacy of LBS (using a multitude of positioning
technologies including RFID and QR codes) in education

"Location-awareness feature of mobile wireless technologies can provide
opportunities for constructive collaborative learning" (Anand, 2008),

 "…RFID technology is useful in providing context-aware learning activities" (Liu et
al., 2007), and

"…the technology can have a positive impact on the learner environment" (Mundy,
Stepehens and Dykes, 2010)

It is this efficacy that the author is trying to tap into in a museum environment,
adapting current models —"Currently, the location-based scheme is the most
frequently used model of u-Learning. The central feature of this location-based model
is the positioning technology…   … Due to the maturity of this technology and the
wide popularity it enjoys, GPS is widely used in outdoor positioning." (Hsiao et al.,
2010)—and using QR codes to overcome the limits the particular target environment
places on the "positioning technology", on the user and on the information provider.

"…we believe that the power of Quick Response Codes coupled with context aware
information will provide an important impact on Human Computer Interaction"
(Rouillard, 2008)

3.3   The here and now

It is interesting to note how awareness of QR codes—in particular QR codes in visitor
attraction / museum contexts—has changed over the lifetime of the project. Since
the project idea was first postulated at least three other endeavours using QR codes
(or at the very least small, smartphone like terminals used to interact at the "point of

sale") have come to light in the UK alone. Most appear to be so new that academic papers haven't even been published yet.

For instance, at UCL, Dr. Claire Warwick and others have come up with the QRator project, a collaborative project between the UCL Centre for Digital Humanities, the UCL Museums and Collections, and the UCL Centre for Advanced Spatial Analysis (CASA) (QRator project, 2011). This project, which can be found in action at The Petrie Museum of Egyptology and The Grant Museum of Zoology, has taken the approach of using small interactive devices—iPads—placed strategically next to items of interest in order to provide an information backchannel. Users are encouraged to add their own interpretation to the data associated with that object[39].

The underlying database used by the QRator project is provided by the "Tales of Things" project (It's a Memory Thing - Tales of Things, 2010) which in itself is part of a larger research project, TOTeM (TOTeM, 2010). These undertakings are perhaps the closest to this project (in spirit if not fact). The differences in approach, though subtle, are in the author's opinion significant and show a fundamental variance in understanding of the user experience in museum situations and difference in expectations of the hoops the user will be willing to jump through in order to participate. In a nutshell, the TOTeM project and the related the "Tales of Things" project seek to tap into the "social memory" (It's a Memory Thing - Tales of Things, 2010) and turn the whole world into a museum with crowd sourced digital memories associated with objects and accessed using, amongst other things, QR codes or RFID tags. This is an extension of ideas previously expressed as far back as the late 90s (Batty, 1997) and which is gaining popularity under the label "The Internet of Things" (Atzori, Iera and Morabito, 2010) wherein almost anything can be (or is already) tagged and have data associated with it.

Back to the variance. Although retrieval is a factor, at the heart of the two projects above is the concept of gathering and storing information (and the development of the necessary channels and storage structures to enable this gathering, classification and storage). It's about tagging "The World" and about the backchannel. What's more, users need a proprietary app[40] to enable this channel (as compared to the proposed use of a web browser based channel in this project). This immediately cuts the number of potential users significantly. On-top of all that, users need to register

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[39] A similar backchannel concept using mobile phones was discussed with one of the potential pilot project partners.
[40] Available for Android and iOS.

in order to use the app properly. The reasons for these approaches are understandable—precise control of the experience and to prevention the type of data abuses that so often accompanies anonymous posting to name but two—but in the authors opinion these measures are sure to put significant barriers in the way of universal adoption. There is also the question of the number of people who need to participate in order to make it a success, a factor recognised by the projects authors "…usefulness of a service like Tales of Things depends largely on its ability to attract a critical mass of people" (Barthel et al., 2010)

The emphasis of this authors research, however, is more to do with the tagging of artefacts and the retrieval of *existing* information at the "point of sale" using widely available, user supplied hardware.

Another related project that this time emphasises retrieval of existing information is QRpedia[41]. This project seeks to allow visitors to scan a code adjacent to an artefact and launch a language appropriate, mobile formatted (and this is where ideas diverge) Wikipedia article (Wikipedia, 2011)[42]. Like the authors project, QRpedia is about re-purposing existing content, layering information and presenting it in an appropriate format. The main difference is that QRpedia relies on crowd sourced data and, as a result, the venue has little or no control over the information (unless they are prepared to divert time and resources to maintaining the Wikipedia entries).

3.4   Why "What's This?"

So what makes this project different?

In all the research encountered to date people were trying to establish if (QR code) LBS education systems could be achieved from a technological point of view and, if they could, would users benefit. They generally did this using participants who essentially had little or no choice as to whether they used the system of not. They were either in the test group or in the control group, user on non-user. This researcher is interested in establishing if, given an unpressured choice, people will choose to use / are able to use such a system (and if they do, do they perceive a benefit[43]). The research is about attitudes and perceptions of the non-users as well as the users. Investigating the possibility of producing such a system cheaply and

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[41] http://qrpedia.org/
[42] The token single Wikipedia reference.
[43] If users don't perceive a benefit they won't come back for another go.

quickly using existing resources (and open source software) is, in many ways, the icing on the cake.

Chapter 4—Methodology

As described in the project aims earlier the researcher proposed to investigate the ease of development of an educational resource using as far as possible existing content and existing technology (no separate app development required). The web site information would be formatted for mobile devices, and a series of QR codes located at the physical venue would be used to link into the website. The content of the web page would, in a large part, be provided by the pilot venue from existing electronic resources (this factor was quite important in order to minimise the cost to the venue—ideally the cost to the venue would be close to zero—and thus encourage their participation) and was intended to add value to the education experience of the visitor (drilling down to detailed information, video, audio, language flipping, etc.).

The researcher would then use this web site, along with Google analytics, on-line survey tools and visitor data provided by the venue to gain an insight into the number of venue visitors actually using the technology, and how they used the technology.

4.1   Web site

As the project revolved around the use of a web resource the choice of web delivery mechanism was deemed to be particularly important.

4.1.1   Choice of the web system

The web site for this project was intended to fulfil two prime functions. Delivery of content—formatted for mobile platforms—direct to the user when a code was scanned, and collection of usage statistics. As the content was to be provided by the venues in unpredictable formats[44] it was decided very early on to use an open source Content Management System (CMS), design appropriate templates, and cut and paste information into those templates. In the event this worked very well.

The final choice was Drupal version 6.22[45] mainly because of the wide range of appropriate modules available, its stability and its security. It also has a well-developed Taxonomy mechanism which allows for some sophisticated data linkages

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[44] In the event data was supplied as word documents, PDF files, PowerPoint presentations, jpg, gif, tiff & png images and links to existing web material.

[45] Joomla 1.5 and Drupal 7 also made the short-list. In the final analysis neither had the modules required and both were considered to be not mature enough.

to be built up (and which proved to be extremely useful when providing the users with information related to the object associated with the QR code they scanned).

4.1.2   Website deliverables

It was decided that the website deliverable portion of the project should consist of two types of web site, demonstrator and deployment. The demonstrator web site was intended to act as a test-bed for new modules added to the core CMS, to provide a proof of concept and to provide a live demonstration as part of the initial approaches to pilot venues.

The Drupal CMS consists of a core system with hundreds (if not thousands) of additional add on modules. Most non-core functions have two, three or indeed more subtly different modules that could be used to implement them. The demonstrator/deployment approach meant that different modules could be installed and evaluated with all the experimenting and coding kept in a "sandbox"—the demonstrator site. The final deployed pilot sites could then be clean installs consisting of only the required modules and nothing extraneous.

4.2   Data gathering

It was recognised before start that getting people to complete surveys in this context—when engaged in a leisure activity, most probably standing up and most probably using a mobile phone—was likely to be problematic even if some form of incentive were offered[46]. With this in mind it was decided that a number of passive data gathering techniques would be employed. These included:

- Web-site logs
- Google analytics, and
- Goo.gl short code analytics

It was decided that three levels of user survey/polling would also be employed to augment the passively gathered information:

- A short demographic survey accessed from the first QR code encountered[47] which became known as the "Welcome" survey.
- A longer user perception survey accessed from the last QR code encountered which became known as the "Exit" survey.
- Exhibit rating which would allow users to give a star rating to the object they were standing in front of.[48]

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[46] Ultimately, both of the pilot venues very generously offered a prize, a book, as an incentive.
[47] Interestingly, on a number of occasions this code was not scanned first (or at all).

In addition a poll would be undertaken to gather data from those visitors who chose not to scan the QR codes.

4.2.1   Questionnaires

Drupal has a number of modules that allow for the construction of surveys and polling users. However, the data analysis tools provided with these modules (and indeed in additional Drupal modules such as "Views") aren't as mature as in some specialist tools[49]. For this reason (and to deal with some anonymity / data protection issues) it was decided to install and use LimeSurvey[50] on the projects server for the more detailed survey, using Drupal modules only for the short surveys and polls. Other web based "free" survey tools like Survey Monkey[51] were also considered. However the free account limits (10 questions per survey, etc.) were thought to be too restrictive. LimeSurvey also allowed for more transparent control of the security of the personal data collected.

4.2.1.1   Design of the 'Exit' survey questionnaire

The 'Exit' survey would be divided into four sections and designed to gather the following information:

- **Hardware and Software**—information about the users equipment and installed software
- **The Experience**—the users perceptions about the use of the system and how it related to their overall experience
- **About You**—basic demographic information and an opportunity to enter a free-form comment
- **Alternative uses**—A brief survey about how the user might use QR codes in different scenarios[52].

It would be designed to be branching and interactive. For instance, if the user answered "No" to the question "Did you have a QR code scanner installed before visiting…" then the next question "Had you ever scanned QR codes before" wouldn't be asked. Similarly it would be tailored slightly for each pilot venue (the Insight Gallery didn't have a wireless network that could be used by the visitors at the time of the trial so the question about wireless networks would be omitted).

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[48] This was mainly intended as a bonus for the participating venue to demonstrate a direct benefit for them over and above an improved user experience.
[49] Export for external analysis was often suggested by other Drupal users as an alternative.
[50] http://www.limesurvey.org/
[51] http://www.surveymonkey.com
[52] This was requested by one of the project partners, RMG.

Initially it was intended that users would be emailed a link to enable them to complete the survey in comfort at a later date. However, after due consideration, it was decided to link directly to the survey to allow users to enter their responses whilst they were still fresh in their minds. In addition, the survey was set up so that users could save incomplete surveys for completion at a later date should they wish to do so.[53]

The complete survey text can be found in the appendices (Appendix 1—'Exit' Survey Questions). These questions were developed with input both from the pilot venues and from RMG. After an initial set of questions had been developed the venues and RMG were invited to add additional question (or suggest alterations/removal of any questions they didn't like). The two pilot venues approved the questions without additions or alterations. RMG suggested the questions in the final section— Alternative uses.

The raw results can be found in (Appendix 2—'Exit' Survey—Raw data).

4.2.1.2 Design of the welcome survey

The "Welcome" survey would be designed to be extremely brief (a single page) consisting of some very basic demographic multiple choice questions that the users could select in seconds. At one pilot site the users were offered the opportunity to sign up for further communication from the venue (with the appropriate data protection declarations). This option was offered mainly to show the venues the ease with which this type of information could be gathered using a mobile phone as much any other reason. The contact data was to be passed onto the venue and not retained by the researcher. The other venue declined the opportunity.

The complete text of these questions can be found in the Appendices (Appendix 3— 'Welcome' Survey Questions and Appendix 4—'Welcome' Survey—Raw data)

4.2.1.3 Design of the 'Did not scan' questionnaire

Of particular interest to the researcher and the partners in the project was the reason people chose not to scan codes when visiting. With this in mind it was decided that a poll of people who didn't scan the QR codes would be undertaken. Obviously this required a site visit so that people could be questioned in person. Once again, in order to minimise user disruption and intrusion, the survey would be kept as short as

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[53] At least two users took advantage of this 'Save' facility (or chose to start at a later time/date). One survey from each venue was completed after 10pm, some hours after closing time (5 pm for the Museum and 6 pm for the Gardens).

possible with as much data gathered by passive observation as practicable. With
this in mind a flowchart style of questioning would be adopted as shown in Figure 11
below. Users would be asked at most four questions (and in many cases less). The
actual questions used are in the appendices (Appendix 5—'Did not scan' poll
questions).

Care would be taken to ensure that visitors were only asked about their scanning (or
lack thereof) when exiting the venue to avoid contaminating the other date being
gathered through scan counts and web views[54].

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[54] One visitor did turn around after being polled and immediately downloaded and installed a scanning app to view the QR code
linked web pages. A note was made of the time and date so that this could be accounted for.
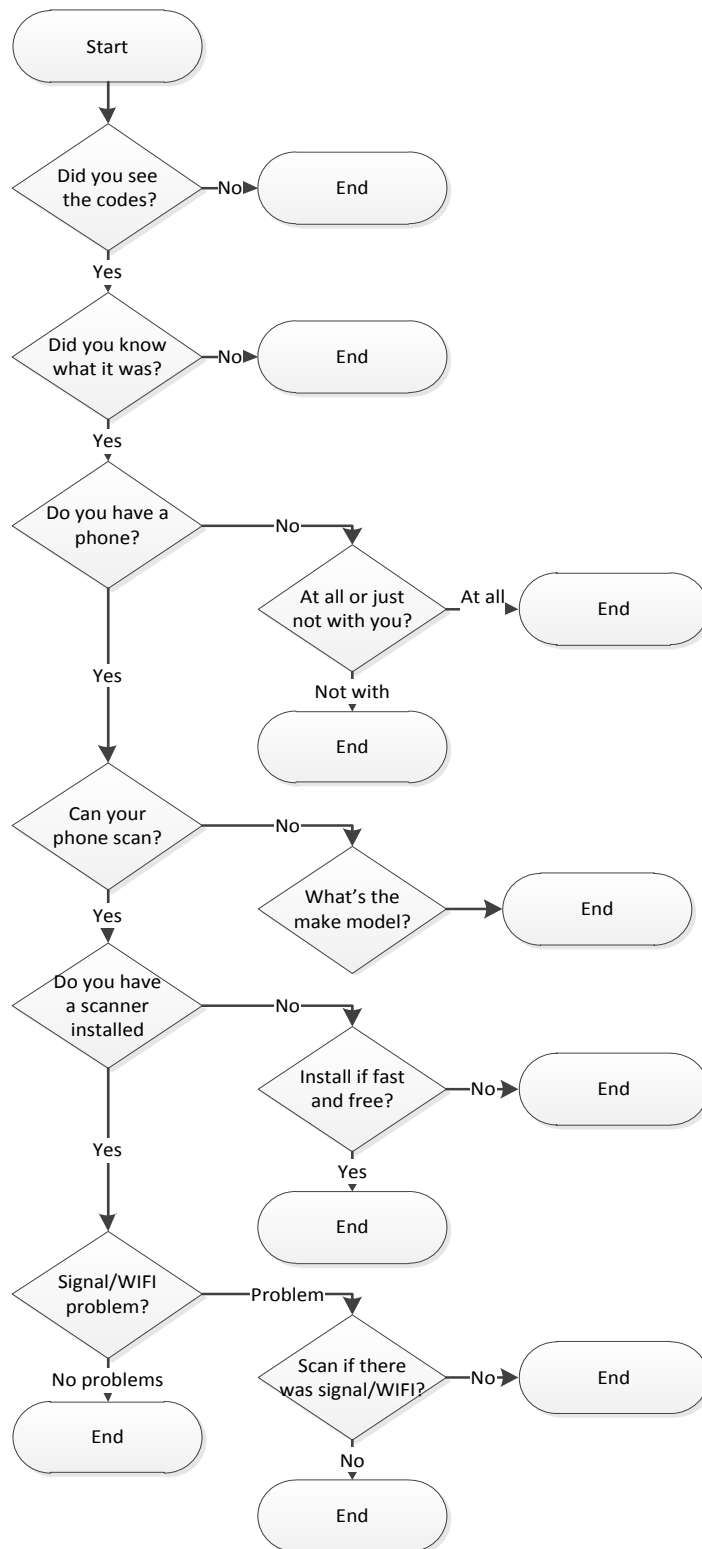
Figure 11—'Did not scan' poll flow chart of questions asked after it was established that an interviewee hadn't scanned a code.

The questions asked and details of the observations made can be found in the appendices (Appendix 5—'Did not scan' poll questions and Appendix 6—'Did not scan'—Raw data).

4.2.1.4 Design of the 'Exhibit Rating' poll

The data gathered from this poll would be of minor importance as far as the core research was concerned. Nevertheless, it was incorporated into the web delivery mechanism to provide a feedback path for the venues that allowed users to "rate" the perceived quality of the artefact displays already in place.

Users would be invited to rate each artefact that had an associated QR code. The rating mechanism would use a standard 5 levels ('Poor', 'Okay', 'Good', 'Great' and 'Awesome'). Users would also be able to cancel their rating or change their rating. The system would be configured[55] such that only one vote for any single item would be registered per user per day.

4.2.1.5 Sample size

There would be four different sample groups associated with the research. Namely:

- Total number of visitors passing the QR codes
- Total number of people who scanned QR codes
- Total number of people who responded to the surveys
- Total number of people who failed to scan QR codes and were subsequently polled

The first of these, the total number of people exposed to the QR codes during the course of the pilot studies, would be estimated based upon the total number of visitors in the pilot period (numbers provided by the venues) and the calculated conversion ratio of the overall visitor numbers on a particular day when compared with a count of visitors arriving in the particular area where the QR codes were installed on the same day. Simple demographic information would also be recorded as part of this count (observed age and observed sex).

$$\begin{pmatrix} \textit{Total number of} \\ \textit{visitors} \\ \textit{exposed to QR codes in} \\ \textit{pilot period} \end{pmatrix}$$
$$= \begin{pmatrix} \textit{Recorded total number of} \\ \textit{visitors to the venue} \\ \textit{in the pilot period} \end{pmatrix} \times \begin{pmatrix} \dfrac{\textit{Observed number of visitors}}{\textit{to QR pilot area on day } x} \\ \dfrac{}{\textit{Recorded number of visitors}} \\ \textit{to venue on day } x \end{pmatrix}$$

Equation 1—Calculating the pilot sample size

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[55] The mechanism used cookies for this.

Based on discussions with the venues concerned and the proposed pilot period this sample size was likely to be in the region of 5 to 8 thousand people per venue.

The total number of people who scanned QR codes would be recorded using Google analytics.

The total number of people completing surveys would be recorded using the survey tool. The (arbitrary) desired target was between 20 and 50 completed surveys.

The final figure, the number of people polled about the reason they failed to scan, would be the number of people approached on a single day by the researcher at each pilot venue.

4.3   Logs and analytics

The passively gathered statistics would rely upon a mixture[56] of standard Apache logs and analysis tools provided by Google[57].

4.3.1   goo.gl QR codes

It appears to be generally accepted that the use of URL shortening services such as goo.gl to keep URLs as short as possible is good practice as far as the use of QR codes is concerned, especially if the short URL is published alongside the code. These services enable users to keep the size and complexity of their codes consistent, and allows them to use the smallest (in terms of number of modules) possible version of a QR code[58].

Some URL shortening services (again including goo.gl) also allow you to generate a QR code alongside the short URL. In the case of goo.gl, adding the suffix ".qr" to the end of a short URL causes the Google chart API[59] to launch and display the related QR code. Changing parameters in the URL of the resulting web page allows the user a degree of control over the resulting QR code (the size for instance)[60]. Of particular interest for this project, however, are the metrics that goo.gl records relating to the use of each short code and this was the primary reason that this URL shortening / QR code generating service was used. These metrics include not only the time and date of each click (or in this case QR code scan), but also the country of

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[56] Some of the information gathered would be duplicated across the tools allowing for cross comparison if required.
[57] These tools have become de facto industry standards.
[58] See the discussion on page 12 for a discussion relating to the differences between the various QR code versions, error correction levels and a definition of modules.
[59] API—Application Programming Interface
[60] There are also a number of more user friendly QR code generator that act as a front end for this API, the ZXing project provide one at http://zxing.appspot.com/generator/ for example.

origin, the browser and the operating system (platform). For the purposes of this research a simple count of the number of scans on each day of the pilot projects was deemed to be sufficient—the information being sought related primarily to establishing if QR codes would be scanned (or not as the case may be). Future projects could also incorporate analysis of the additional data available—for instance peak scanning times. Google have provided an API (Google, 2011) that allows programmatic interaction with the stored information for however long it is stored so future researchers could even return to the source data for the two pilot projects undertaken as part of this research[61].

It was recognised early on in the development phase that, although displaying a short URL alongside a QR code is considered to be good practice, there would be no way of identifying in the recorded data whether a user had typed in that short URL rather than scan the adjacent QR code. With this in mind each landing page[62] had two short URLs associated with it. The first was used to generate the QR code and the second was used as the displayed short URL printed alongside the code. In this fashion it would be possible to establish the route through which a landing page had been viewed (an interesting datum in its own right). Some short code generators don't allow duplicate URLs to be used to generate different short URLs. They will re-use an existing short URL if it exists. Fortunately goo.gl is not one of them. If you are signed in you can generate multiple short URLs pointing at the same long URL, another factor in the decision to use goo.gl.

4.3.2   Google analytics

Google analytics relies upon a unique tracking code embedded in the web pages to be tracked (normally between the <head></head> tags). Drupal 6 provides a module to do this embedding automatically once the unique code has been entered in the management console.

When a page is viewed a Google server is referenced (through a java script), allowing the tool to record a plethora of information[63] relating to the browser client. Google analytics provides a number of sophisticated reporting and analysis tools— time on site, bounce rate, traffic sources and so on—that facilitate the interpretation

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[61] It's worth noting that short URLs generated with goo.gl are public. Anyone can access information about the URL by simply appending a "+" after the short URL. For instance entering http://goo.gl/hZDfg+ displays information about the short URL goo.gl/hZDfg (in this case one of the landing pages used in the pilot projects).
[62] Any page linked to directly through the scanning of a QR code is referred to as a "landing page" or "QR code landing page" throughout this document.
[63] It's as well to note that this information doesn't contain any personally identifiable data and is not covered by the data protection act.

of this information. However, for the purposes of this research we were concerned mostly with the number of unique visitors and which pages they viewed. Because of the way the QR content sites were designed to operate—direct links to "landing pages", no inbound links, and so on—some of the analysed information would be of little use anyway.

4.3.3   Web logs

The LAMP server used by the project used Apache as the web server element running on Ubuntu 10.04. This type of web server software generates access and error logs that can be analysed using any one of a number of widely available tools. In this case Advanced Web Statistics[64] 6.9 was used. This allowed information such as the "most popular" viewing time of day, "most popular" viewing date and HTTP status codes to be recoded and analysed. It was envisaged that, although interesting in itself, much of this information would be surplus to the research requirements of the project.

Additional in depth analysis of certain periods would also be undertaken using Deep Log Analyzer Pro[65] to provide reports and feedback to the pilot venues. As above, the information in those reports would be interesting, but probably surplus to the requirements of this research.

4.4   Languages

The decision to provide a user experience in both English and Welsh was taken early on in the project. Primarily this was to encourage the acceptance of the concept of running a pilot project by a visitor attraction in South Wales. Most publically funded venues (and many privately funded venues) in Wales have Welsh language policies that require all publications—including web sites—to be produced bilingually. Offering to run a bilingual project greatly increased the chances that one such venue would take it on for the pilot. It was also assumed that most of the content the venues had available would be bi-lingual. In the event approximately 95% of the materials provided were indeed supplied in the two languages (or translated by the venues themselves).

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[64] http://awstats.sourceforge.net/
[65] http://www.deep-software.com/

Running the project in the two languages also afforded an opportunity to demonstrate the multi-lingual capabilities of such a system.[66]

4.5 Legal, Social, Ethical and Professional Issues

A number of issues were considered here:

- Intellectual property
- Data protection
- Informed consent
- Property damage
- Child protection
- Transparency

4.5.1 Intellectual property

Firstly, considering the intellectual property of the web site content, as it was intended that the majority of the content for the web aspects of the project would be provided by the third party venue from existing digitised materials, in theory these materials should have been cleared for publication electronically already. However, steps would be taken to confirm this and to ensure that any new materials were either original or cleared for publication. In the event no new (primary) materials were written for the project by the venues. Some short "glue" phrases were written to link materials by one of the venues. All other original materials (such as background information, policies, user guidance and some photographs of exhibits) were created by the author.

In one case a photograph embedded in a document appeared to have been sourced from a web page and staff at the venue were unable to confirm that it had been cleared for publication[67]. For the pilot the document was to be provided as a download as well as having its content "chunked" into a number of web pages. Where the image appeared on a web page—the instance where the author would be deemed to be its publisher—it was replaced by an original photograph[68].

4.5.2 Data protection and informed consent

The next issue considered was that of Data Protection. Broadly speaking the research was intend to gather two types of data, web statistics—which aren't

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[66] The Drupal web interface is available in Welsh. It also has translation management tools that make handling multiple languages for the content relatively simple.

[67] It had been published a number of years previously and most of the source material had been misplaced.

[68] Given that the web site would be "live" for only a very short period and given that no links would be created leading to the QR code "landing" pages it is unlikely that this picture would ever have been noticed by the outside world. It may even have been covered under "Fair use". However, it was thought prudent to follow the letter of the law rather than "hope for the best".

personal or traceable to individuals and hence outside the remit of the DPA[69]—and survey information. Some of the survey information would be anonymous in nature and some would be more detailed with some aspects of personal information associated with it (especially as it was envisaged that an incentive in the form of a prize draw would be offered in return for filling in a more detailed survey—contact information would be required in order to pass on the prize). The overarching policy was that if users were requested to divulge any personal data they would be made aware what the data was to be used for—to whit this research project. In addition, no personal information would be published or passed onto any third party, including the project partners without first obtaining the users permission. Any personal data collected in this fashion would be stored on encrypted media and disposed of securely after the completion of the research.

In the event both venues were initially keen to collect user email addresses for future marketing purposes. However, after discussions with their data protection officer, one venue decided to distance themselves from the collection of data to avoid being put in the position of being (or being perceived to be) a data controller (as defined by the DPA) for the personal information gathered (in this case email addresses)[70].

In order to satisfy the requirement that all personably identifiable data be kept separate—and seen to be kept separate—from the metrics gathered as part of the project additional procedures were put in place. Firstly, the 'Exit' survey was set-up to be anonymous. On completion of the survey users would be invited to click on a link that launched their local e-mail client with a pre-addressed—addressed to a specially created email account—email loaded. This ensured the separation between survey and prize draw entry.

Secondly, all pages had a footer linking to a Disclaimer and a Privacy Policy (see Appendix 7—Site Policies) making it clear what the data was being gathered for and what would be done to any personally identifiable data at the conclusion of the project.

Finally, at any stage where personal data was to be gathered, a further short declaration about the use to which it would be put would be made.

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[69] Data Protection Act 1998

[70] To clarify, they would have liked to have collected the data but the procedures they would have had to complete couldn't have been accomplished in the short time scales of the pilot projects.

To reiterate, the overriding principles that would be adhered to throughout all aspects of this project would be those of informed decisions and informed consent. Participants would be offered the opportunity to participate or not and if potentially sensitive information was to be gathered their consent would be sought beforehand.

4.5.3   Cookies

The web sites would be using cookies to track QR code scans, prevent multiple submission of surveys and to provide additional non-volatile option settings (for functionality such as language selection and text size). These cookies would have appropriate expiry dates set and, if necessary, be used with user permission obtained first.

4.5.4   Child protection

Given the ubiquitous nature of mobile phone communication it can no longer be assumed that all smart-phone users are adults. It was thought to be inevitable that, given the nature of the venues envisaged for the pilot, that some of the users would be under 18. Thus child protection issues would need to be considered. However, it was also thought to be unlikely that any materials published would be unsuitable for minors and care would be taken to ensure that, wherever possible, any externally linked material would also be suitable (although obviously it is not possible to control content on third party web resources). In the event no external links were necessary. The only other area with potential child protection ramifications was that of gathering email address (for instance when entering the prize draws). Users would be asked to declare that they were over 16 or had permission to enter as part of their submission—in effect parental permission would be sought first.

4.5.5   Property damage

The pilot project would involve placing signs in strategic positions at venues which, by their very nature, would likely to be sensitive to structural damage. Care would be taken to ensure that signs were installed in such a fashion so as to not damage the fabric of the venues in any way—for instance discrete freestanding signs could be employed. The conservators at the venues would also be consulted as to the most appropriate methods to be used to achieve this aim.

4.5.6   Transparency

The possibility of offering incentives for taking part in additional detailed research has already been mentioned above. These incentives were likely to be in the form of

entry into a competition. Any management of such a competition would be done in as fair and transparent fashion as possible. Care would also be taken to try and ensure that any possible distortion of the results—by offering an incentive only attractive to a small portion of the sampled population for instance—would be minimised.

4.6   Third parties

It should be noted that this project would be carried out with the participation of an additional third party, Research and Marketing Group based in Cardiff. They have an interest in QR codes for market research purposes and have contacts with many of the organisations in Wales that would be ideal candidates for the pilot studies. They offered to pay some of the costs associated with the project (production of free-standing signs, translation, and so on) in return for some branding on the displayed materials, some market research oriented questions in surveys, and access to rigorously researched data.

It was made clear to RMG before embarking on such an arrangement that they would have no access to personal information, that branding could only be undertaken with the consent of the pilot venues, that questions added onto any surveys would also depend on the agreement of the venues (and would in addition be optional for the participants) and that they would have no control over the direction of the research and results, to which they agreed.

Some other organisations would also be indirectly involved with the project, but only insomuch as they were providing services on a commercial basis that were used by the project (vps.net providing servers for instance and Google providing URL shortening & email services).

4.6.1   Contacts with pilot venues

The pilot venues would first be approached through established channels of communication provided by RMG in order to ascertain the most appropriate person or department to approach for further discussion. Following initial contact, meetings on site would be undertaken to demonstrate the concept and establish levels of interest.

If an agreement was reached contact would be maintained through telephone and email exchanges as well as further on-site visits to:

- Agree the placement for the pilot (unless the venue was very small the pilot was likely to be in a sub-site within the venue) and the artefacts to be "QR coded"
- Survey the existing information provision
- Install the QR Codes
- Poll some of the venue visitors (on one or more occasions)
- Remove the QR Codes after the conclusion of the pilot
- Present findings to the management at the venue

It was anticipated that there would be a need to approach many sites with a view to achieving a successful pilot placement with one. It turned out that, once the right person had been approached and they had had the concept demonstrated to them, all three of the venues initially contacted wished to participate, a measure perhaps of the current and growing interest in the layering of information at these venues and their willingness and wish to embrace new technology. One of these three venues had poor network coverage and was deemed unsuitable (although links were maintained with a view to undertaking future projects once infrastructure improvements had been implemented). The other two venues provided interesting contrasts in a number of key areas. They each had a different visitor demographic—one had a significantly older demographic—different location—one was city centre and the other in was rural—and network provision—one had poor mobile connectivity, but was well served with a wireless network in certain areas and the other had good mobile connectivity, but a wireless network that had been to all intents and purposes switched off. It was decided to proceed with both of these venues.

Chapter 5—Implementation

This chapter covers the major design and implementation decisions taken over the course of the project—in particular those relating to the hardware, software and the data gathering tools employed—and the reasoning behind the decisions.

5.1 Hardware

For the sake of credibility with the users of the system and to a lesser extent credibility with the partners, it was decided not to take advantage of any web provision available to students at the University. It was felt that a web address in the format http://students.comp.glam.ac.uk/03233588/ wouldn't be appropriate. In addition, although the student space supports php and MySQL is reported as being present when queried[71], it wasn't clear if the version would be suitable, nor if sufficient privileges could be granted by the administrator to enable effective development and experimentation. For this reason a virtual private server was acquired. A domain name was also registered, WhatsThis.mobi[72], to form the central facet of the projects corporate identity.

The server was set-up with a number of instances of Drupal—see 4.1.1 Choice of the web system (above)—and development commenced.

5.2 Demonstrator

In order to attract willing partners for the pilot project (and to facilitate the explanation of potentially new concepts) it was felt to be advantageous to be able to demonstrate a working system. Thus, after the initial, investigation of appropriate platforms and design tools (partially alluded to in previous chapters) work commenced on the development of this demonstrator.

Key factors taken into account (in no particular order) were:

- **Optimisation**—It had to be optimised to run on smartphone browsers. Whilst it is true that un-optimised web sites can run on many mobile phones, stopping to resize the screen after every click certainly doesn't enhance the user experience. This meant that all the assets had to be pre-processed to reduce their size as much as possible and to match common mobile browser resolutions without sacrificing too much quality.

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[71] <?php phpinfo(); ?>
[72] A concatenation of "What's this funny looking black and white square thingy" and .mobi to add weight to the idea that the web site was designed for mobile use.

- **Fast and "light"**—It had to be able to deliver the goods in areas of (potentially) poor network coverage.
- **Portable**—It had to be possible to carry it around easily and set it up quickly and easily.
- **Versatile**—It needed to be able to demonstrate a wide range of potential uses to decision makers at prospective pilot sites who would in all probability have radically different agendas. For instance, for one person the layering of information or the ability to drill down to in-depth commentary might be important. For another the ability to flip between languages might be of prime concern, or the ability to provide audio commentary tied to a location.

Some of these features would be achieved through pre-processing—for instance a test 10 minute long (spoken) audio track was reduced to approximately one third of its original size by lowering the sample rate and editing out a blank passage at the end of the track. After processing it still sounded more than acceptable on a mobile phone speaker[73]. But as far as possible it was intended that optimisation process would be semi-automated and built into the file upload and edit process on the web site. This was mainly with a view to future deployments where content entry could be undertaken by non-technical staff.

5.2.1 Demonstrator Taxonomy

It was decided to use a "virtual museum" as the model for demonstration purposes. As the intention from an early stage was to demonstrate to the National museum in Cardiff some pictures and content from the "Curators Choice" collection were downloaded to provide some familiar imagery[74]. This source of material had the added benefit of being, in the most part translated into Welsh already. It also provided an excellent method of demonstrating the re-purposing of content (as opposed to generating new content). As the venues to be approached were likely to cater for international visitors it was also decided to provide a third translation, in this case French generated by passing the text through Google Translate[75].

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[73] It was reduced from nearly 10 mb to just over 3 mb
[74] These would be used purely for demonstration purposes, not externally linked to and deleted at the end of the project.
[75] A disclaimer re the quality of the resulting French was added to the points discussed when demonstrating the system.

Drupal is very much Taxonomy oriented and this mechanism was used to link related content. The content gathered for the demo gave rise to the following taxonomy:

Celtic culture and history			
↘	Celtic Village		
Heavy Industry			
↘	Coal Mining Industry		
	↘	Coal Mines	
		↘	Pit ponies and Horses
	↘	Miners strike	
		↘	Miners Strike badges
↘	Iron and Steel		
Historic Buildings			
↘	Castles		
↘	Churches		
	↘	St Teilo's church	
Welsh Culture and Traditions			
↘	Eisteddfod		
↘	Love Spoons		

Figure 12—Demonstrator site Taxonomy

5.2.2 Completed demonstrator

These screen shots show samples of some of the features incorporated into the final version of the demonstrator.
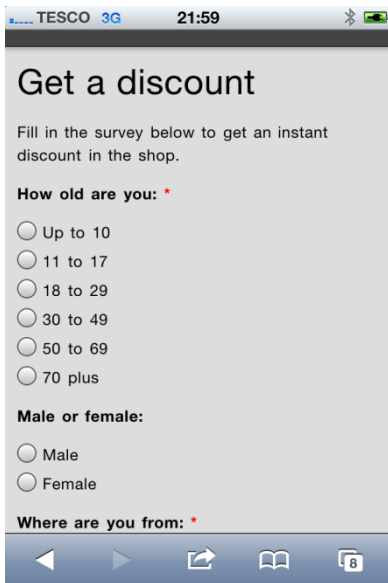
Figure 13—Basic survey page
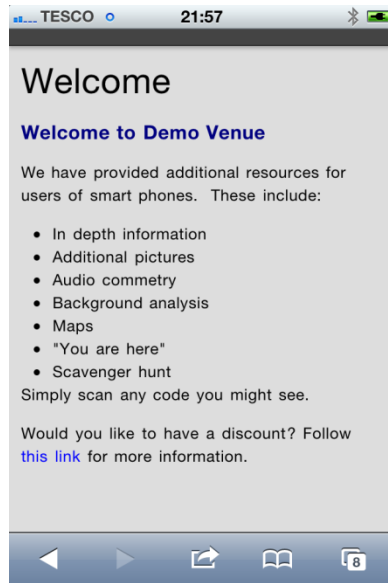
Figure 14—Generic Welcome page

Figure 15—Generic landing page. The thumbnail is clickable to show a full sized version.

Content title

User rating system

Body text

Language changer drop-list
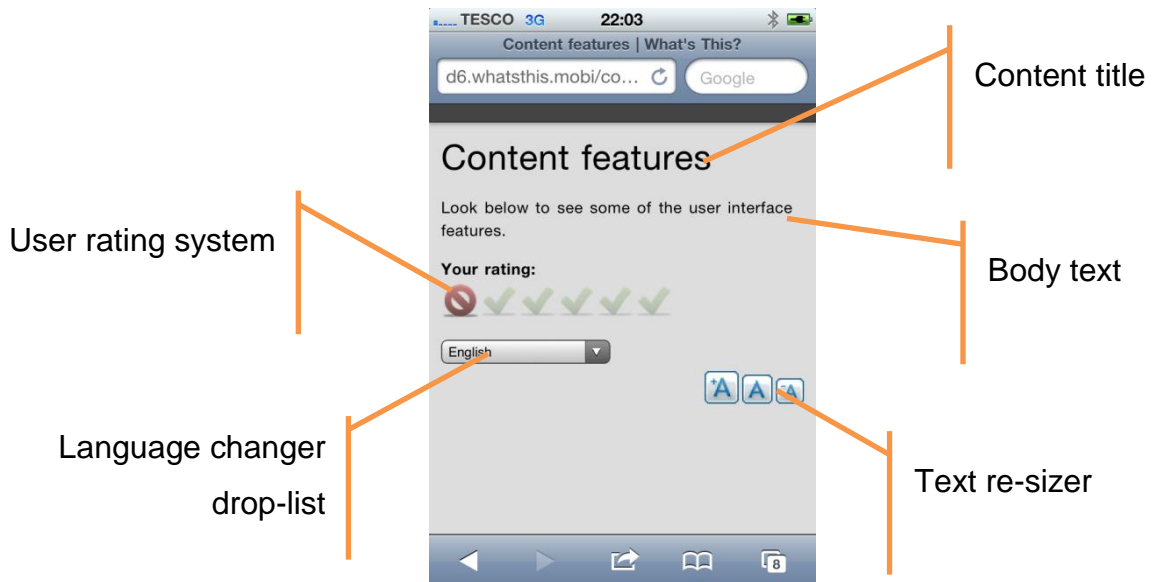
Text re-sizer

Figure 16—Screenshot illustrating some of the features of the user interface
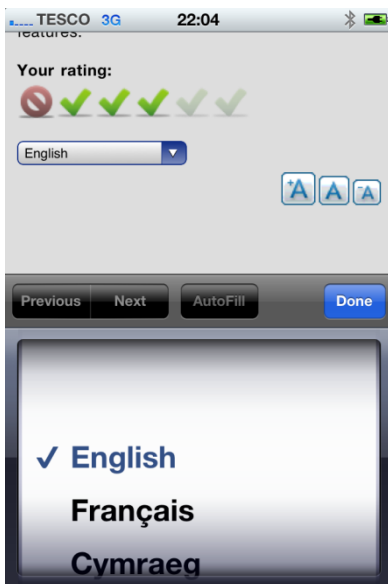
Figure 17— Language selection in action
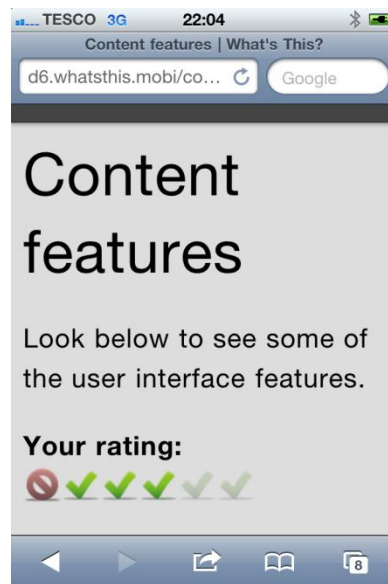
Figure 18—Text re-size in action

Figure 19—Audio link
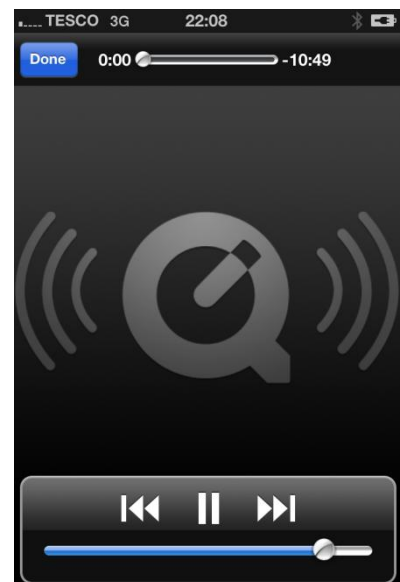
Figure 20—Audio in action

The "virtual museum" was brought to life through the use of additional props

purchased from Ikea as shown below in Figure 21—Prop from the "virtual museum"

demonstrator kit.

Figure 21—Prop from the "virtual museum" demonstrator kit

5.3   Pilot project partner recruitment

With a functioning demonstrator system the next stage was to establish relationships
with potential partner organisations and persuade one of them to be a pilot venue.
The criteria used to select the organisations to be approached included:

- **Prior relationship—**RMG, the commercial partner in the project, had some
  established relationships (or was in the process of establishing relationships)
  with potential partners including CADW and the National Botanic Garden.
- **Need—**the venue needed to have an educational remit and a "product"
  suitable for the proposed information layering.
- **Footfall—**the larger the sample the better.
- **Distance**—they needed to be reasonably accessible to a base of operations
  in Cardiff.
- **Network provision**—a suitable connection was required either using WI-FI or
  using the mobile data network.

- **Content**—there needed to be some suitable pre-existing content to work with.
- **Resource and buy in**—although it was envisaged that the majority of the work would be undertaken by the researcher there needed to be a degree of buy in from the partner venue and someone at that organisation who was prepared to take ownership and ensure that content was found and decisions made in a timely fashion.
- **Progressive attitude**—the staff and management at the venues would need to be forward thinking and willing to try new ways of doing things.

Fortunately, South Wales is well served with organisations that match this profile in almost every aspect and it proved relatively simple in the end to approach appropriate bodies.

Because it was initially thought that partner recruitment might prove to be difficult and that it would take a long time to achieve a positive decision, three organisations were approached simultaneously with a view to running the pilot at one of them. All three proved to be keen and agreed in principle almost immediately. One didn't have suitable network coverage, but the other two were suitable. In the event it was decided to proceed with both to increase the potential size of the sample and because of their contrasting characteristics (urban versus rural, wireless versus 3G, old demographic versus young demographic, and so on). It was thought that, with care, further insights could be teased out from these extended, divergent data sets.[76]

5.3.1   Pre approach survey

It was thought to be prudent to check out the network coverage and current information provision before approaching any organisation. There was little point in offering what couldn't be delivered, offering something that was of no use, or (worst case scenario) offering something they were already doing[77]. Hence a site survey of organisations in Cardiff to be approached regarding a possible Cardiff central / Cardiff environs pilot was undertaken.

The Cardiff Story (in the Old Library and behind the Tourist Information office) was the first venue surveyed. Unfortunately it was closed on the day of the survey because of a "royal visit" to officially open their facility. Test scans and web connections in the outer reaches (the tourist information centre) proved to be

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[76] In addition, it was hoped that future projects could be on the cards and the researcher didn't want to antagonise either party by snatching the pilot away after having initially offered it to them.

[77] In all the surveying undertaken the researcher only ever saw one single QR code, on a video screen—one "slide" amongst many on that screen—in the Insight gallery in the National Museum, Cardiff. This code led to a non-mobile optimised web page about shell fish classification. It is interesting to note that museum staff in charge of that gallery didn't know it was there until it was pointed out.

relatively slow. Enquiries at the tourist office reception desk elicited a contact name, Jim Groves.

The National Museum, Cardiff was the next to be surveyed. It had a surprisingly strong 3G connection on O2 throughout the building. Test scans proved to be quite fast. It also had a number of self-contained areas (the Origins exhibit for instance) that would be ideal for a pilot. Whilst there an enquiry dealt with by very friendly and helpful staff in the Clore Discovery Centre generated the name Deborah Spillards. Apparently Deborah Spillards was the person "most likely to be interested in that sort of thing".

The final Cardiff site survey was undertaken at the National Museum, St Fagans, and it proved to be very disappointing. On the face of it, an outdoor museum such as St Fagans would be an ideal candidate. However, it had very poor mobile network coverage. It did have wireless coverage inside the buildings but this appeared to be a closed network. A future, full scale outside infrastructure installation could sort out these problems and make it a perfect venue for this type of information dissemination, but in the short term it was deemed not suitable for this project.

The pre-approach site survey for the National Botanic Garden was undertaken by a colleague from RMG who reported reasonable mobile network coverage[78].

5.3.2   Partner incentives

It was recognised that any benefits arising from a partnership with a potential venue should not be all one way. It would a "big ask" to expect them to provide space, content and resources for little more than a "Thank you" at the end of the pilot. However, it was also recognised that professional curatorial staff at most of the venues to be approached would more than likely be aware of developments in layering technologies, if not QR codes themselves, especially if the recruitment criteria outlined above were applied. This offering would enable them to see if such technologies could provide benefit for their "customers" with little or no risk, both financial—the researcher would be picking up the tab—and reputational—the project would exist in a small area of their organisation and need not be widely publicised[79]—to themselves (assuming that they had not already run such a pilot). This could be a win-win situation. This incentive was bolstered by an additional offer

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[78] This turned out to be true only for Vodafone users. All other networks tested gave poor to unusable results when surveyed at a later date.
[79] Should it prove to be a dismal failure then it would be the researcher who had failed, not the organisation.

to return after publishing the results and to present findings in a dissemination event tailored to the research aspirations of the venue in question. In the event this offering proved to be so attractive that all the venues approached wished to participate. The researcher appeared to have hit the sweet spot between staff being aware of the technologies (if not QR codes themselves then something similar) and full blown roll out. Indeed, when questioned, many of the staff involved suggested that the only things holding them back were a) financial reasons, and b) evidence based research to ascertain the suitability of such technology. In actual fact, the venues felt that they were getting such a bargain that they offered to provide the prize for survey participants.

5.3.3   The Cardiff Story

The Cardiff Story[80] was approached in early July and a meeting was held on-site with Jim Groves (PR Officer) and Rachel Carney (Learning Officer). The system was demonstrated in their staff room (on the top floor). Both were very enthusiastic and a "wide ranging discussion" ensued. Unfortunately, the mobile signal in the galleries (1st floor, ground floor and basement) proved to be poor and there was no alternative publically available network. However, future infrastructure developments may include a wireless network throughout the building. In the light of this, their active participation in the pilot project was put on hold.

5.3.4   The National Museum Cardiff

Deborah Spillards of the National Museum, Cardiff was also approached in early July. The system was demonstrated in the coffee shop in the ground floor foyer. An agreement was reached to run a pilot in the Insight Gallery at the rear of the Natural History section. The previous survey by the researcher had shown that the mobile signal in that area was adequate. There was also a "Public" WI-FI in many areas of this building which, although switched on and popping up whenever an attempt was made to access the net, was password protected. Apparently the WI-FI had been disabled due to "abuses", but would be re-enabled "soon" when measures had been put in place to prevent future reoccurrences. When pressed, no date was forthcoming (and it had been in that state since earlier in the year).

The following was agreed:

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[80] http://www.cardiffstory.com/

- The researcher would provide and populate the web system (to be hosted by the researcher) with content provided by the museum and branded to reflect their corporate ID.
- The web site and materials would be bi-lingual (English/Welsh)
- The researcher would provide all the QR codes.
- The researcher would provide the signs, the museum would provide sign holders.
- The researcher would draft all the surveys and glue pages which the museum would approve (and possible add to).
- The museum would provide an incentive for people filling in the survey (in the form of a prize for a prize draw)

5.3.5 The National Botanic Garden Wales

The last organisation to be approached in July was the National Botanic Garden of Wales. A meeting was held on-site with Natasha De Vere (Head of Conservation and Research), followed by a meeting with Peter Hamilton (Marketing)[81].

Both appeared to be very enthusiastic, albeit from different perspectives. On the one hand Peter was interested in the marketing aspects and driving membership, whereas Natasha was interested in the layering potential. Once again an agreement in principle was made on the spot with similar terms to those agreed with the museum. One aspect that particularly appealed was the ability to present information in both English and Welsh. Apparently the Gardens has to date been unable to publish as much as it would like bilingually (their web site[82] being a case in point) and this bilingual project could go some way towards placating their critics.

On the same day a site survey was undertaken using an iPhone on Tesco (O2) and an HTC Android phone (Vodafone). The survey produced mixed results. The original (pre visit) concept for the Garden was to use QR codes to enhance the Green Technology Trail which has points of interest all over the grounds. Although the Vodafone results were reasonable[83] over most of the trail, O2 ranged from no connection / poor to just acceptable throughout[84]. On the other hand, there were strong and open wireless connections in the Great Glasshouse and the Tropical glasshouse in the double walled garden

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[81] At a later date discussions were also held with Rosy Plummer (Director), Bruce Langridge (Interpretation Officer) and Simon Goodenough (Curator)
[82] http://www.gardenofwales.org.uk
[83] The signal strength never dropped below 14 on the ASU scale (which is not a measure of data carrying capability but does give a good indication of how good the data capability is likely to be—10 and above is likely to be reasonable).
[84] Signal strength never went above 2 bars from 5 apart from just outside the Great Glasshouse.

Actual test web page data transfer trials gave slow but acceptable page loads for text heavy pages on the 02 network, but the network struggled in many places on the grounds when faced with images and audio. The Vodafone network gave acceptable to good results for all test pages across the whole of the grounds.

In the light of this, two proposals were put forward to the management at the Garden, a Green Technology Trail (with appropriate measures in place to overcome the network problems) or an installation in the Great Glasshouse (the researchers preferred option).

The measures proposed for the Green Technology Trail were:

1. Warnings re poor network coverage for non-Vodafone users, and/or

2. Low bandwidth (for example text only) choices for downloaded information, or

3. Expansion of the Gardens wireless network with external repeaters

1 and 2 would be relatively simple to achieve (users could make a choice at the start and then be fed low bandwidth materials for all subsequent scans). However, it meant that the experience would be completely different for two groups of users and that would probably skew any "satisfaction" oriented results. 3 was considered to be impractical in the short term, both in terms of time and cost constraints, although it could perhaps be considered for a future project.

The Glasshouse had a lot going for it. Particularly positive aspects included:

- It was an enclosed environment with restricted entrances where introductory information and exit poll information could be displayed.
- It had good wireless network coverage.
- It was dry (unlike the Tropical House) so people would more likely to be comfortable with taking out their phones.
- It was an "all weather" area of the Gardens so the wonderfully fickle Welsh weather wouldn't have an impact of the results.
- It already has three "Trails" within—Ecology, Survival and Sensory—each of which had associated material already available.
- It (reportedly) had high foot-fall.

All in all it appeared to be the ideal choice. The management at the Garden evidently agreed and it was selected as their pilot location.

5.4   Data gathering

The intention of the web design outlined earlier was to make the scanning experience as slick as possible for the user without interruptions and asides. The process would as far as possible be:

- point
- scan
- read
- drilldown ("tap for more", etc.)
- repeat

without break or interruption. However, the pilot installation was also a golden opportunity to gather information about the type of user who scans a QR code (and also the type of user who doesn't). With this smooth uninterrupted scanning process in mind a number of different data gathering techniques were employed, passive—Web logs, Google analytics, and similar tools—and active—polls and surveys—all designed to maximise the data gathering potential without compromising the user experience.. The polls were relatively straightforward. All it takes is a little bravado and a lot of standing around. The surveys were a little harder to handle.

5.4.1   Welcome survey.

It was decided to split the surveying into two main opportunity slots. An initial very
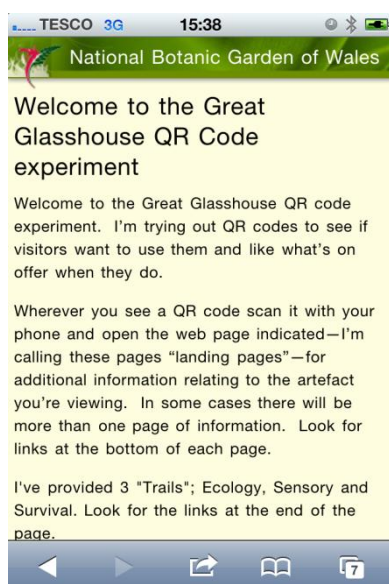
Figure 23—Welcome landing page

brief "Welcome" survey was designed and implemented using the Drupal Webform component and integrated into the pilot web sites. Users were presented with a QR code and welcome message at the entrance to the pilot area (Figure 22)[85] which linked them to

Figure 22—Welcome sign in situ in the Great Glasshouse

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[85] See Appendix 9—Signs and Codes artwork for details of the signs used

basic instructions (Figure 23) and allowed them to fill in this first survey (Figure 24).

This survey established some basic demographic information (age, sex, interface language—as a hidden field defined by the currently selected language—and where the user lived along with the opportunity to leave an email to join a mailing list[86]). It was very brief and, although some fields were "compulsory"—the minor annoyance to the user of compulsory fields was considered to be outweighed by the desire to gather some information rather than receive a blank form—the users were under no obligation to submit it in order to take part in the experiment. It was felt that if the survey were short enough and quick enough there shouldn't be a deterrent effect.

Figure 24—"Welcome" survey

5.4.2 Exit Survey

The second survey was to be presented at the end, the "Exit" survey. As with the "Welcome" survey, users were offered the opportunity to scan a QR code at the exit (see Appendix 9—Signs and Codes artwork for details of the signs used) which in turn led them to a page outlining the prize draw and linking to the survey (Figure 25). This survey was designed to be a little more detailed than the earlier one (qualitative questions about the users experience with the technology for instance). The problem was that, as this was to be presented at the end of the experience, it was thought that many people would probably simply not bother to participate. One way around this would be to offer some form of incentive to encourage take-up. Initially an auto generated voucher was considered

Figure 25—Survey link from the "Exit" scan

("Show this at the shop for a discount"). This was ultimately rejected on the grounds that:

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[86] This feature was incorporated mainly as a benefit for the venue partners.

a) It was open ended—the number of people who would take part was an unknown quantity so the cost implication would also be unknown until the project ended

b) Users may not be at the venue when they completed the survey[87]

An alternative option considered was that of a prize draw. A single prize would be offered, the winner to be selected at random from those who completed the survey. Ultimately type of incentive was chosen on the grounds that:

a) It wasn't open ended (the cost of running the draw, the prize, would be known from the outset, and

b) It didn't require the winner to be at or return to the venue in order to redeem it. It could be posted (assuming of course it was suitable for posting).

It is interesting to note that nearly 65% of those who completed the survey went onto enter the prize draw, which suggests at the very least a strong link between willingness to participate and the offering of an incentive.

In an ideal world follow up interviews or additional research post visit would be a good idea. However, such a long term commitment was thought to be beyond the remit of this project which was seen more as a baseline assessment.

LimeSurvey was chosen as the tool of choice (as opposed to one of the many "free" on-line offerings) in order to have a more complete control over the number of questions, to be able to control the formatting (to match the branding of the original web sites), because of its built in data analysis tools and most importantly, to ensure the security of the data. In addition the researcher had used the tool on previous occasions.

5.4.2.1   Survey settings and branding

The survey was set to be anonymous—to avoid potential data protection and child protection issues—and also had the optional "save and resume" setting turned on to give the users every opportunity to complete[88]. It was also designed to be filled in from start to finish in less than five minutes—all questions were optional and multiple choice (save one that allowed free form text comments to be entered).

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[87] The original idea for linking to this survey involved requesting an email from the user first and then sending them a link to the survey so that they could complete at leisure—possibly even when sitting back at their home computer. For various reasons discussed elsewhere this was later changed to be a more immediate call to action with the survey offered in a mobile friendly format so that people could complete it on the spot and then enter their email address if they wished to enter a prize draw. However, the survey still offered the opportunity to save and complete later so the "user not present" concept still applied.
[88] It's not known how many participants took advantage of this, but as the survey was designed to take less than five minutes to complete, it's unlikely that any did.

It is interesting to note that the average time spent on the survey at the Gardens was 6 minutes 28 seconds (median 5 minutes 4 seconds) and 19 minutes 2 seconds[89] (median 4 minutes 39 seconds) at the museum.

As alluded to above, the branding of the original QR linked web sites was carried across to the survey site to help to keep the user experience contiguous, something that would not have been possible had one of the on-line, web based survey tools been used.

5.4.2.2   Question design

The survey was divided into four self-contained sections:

- **Hardware and software**—questions about the users scanner (which may or may not have been a phone), the software they used to scan, their network connection and related issues.
- **The experience**—qualitative questions about their personal experience, if they found it to be of benefit, if they used any of the potential avenues for later perusal of information and reflection, and related issues
- **About you**—this area essentially repeated the information gathered in the "Welcome" survey. There was no mechanism to tie in submissions to the "Welcome" survey with this survey and it was felt to be important to connect the other answers on this survey with demographic information. In addition users may not have completed the original survey. This area also had a free-form text comment area.
- **Alternative uses**—questions relating to possible future use of codes in the wider community (included at the request of the commercial partner, RMG).
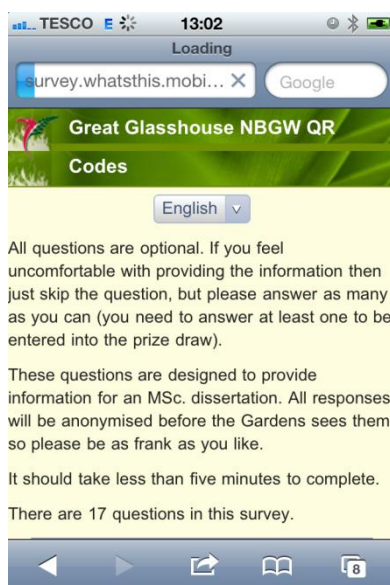
Figure 26—"Exit" survey introduction.

As each section was completed, clicking on **Next** stored the responses in the database. Thus, quite apart from making survey easier to handle from a user experience point of view, this chunking of the survey allowed useful data to be collected even in the user failed to finish it.

On loading the survey the users were first introduced to the basic surveying parameters (the reason behind it, the anonymous nature of the information gathered, the optional nature of the data gathered and so on).

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[89] This result was skewed somewhat by two users, one of which spent 39 minutes on the survey and the other over 100 minutes! It would appear that they took the suggestion to "go to the coffee shop and do it over a cup of coffee" to heart.

The majority of questions were set to be a single choice from a range of two or more answers including "Don't know", "Other" and "No answer" as appropriate. Wherever it was in use "No answer" was the default option (see Figure 27). Where a single choice was requested from a large number of items (for instance when choosing the mobile provider) information was supplied as a drop list with the most common options at the top. Care was also taken to ensure that the choices offered were mutually exclusive.
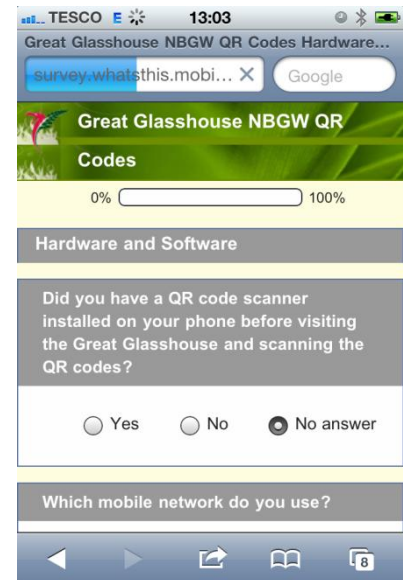
Figure 27—Typical survey page

For the qualitative choices a 5 point, Likert like scale was employed. The standard short statement style of question/decision was felt to be unsuitable—too prescriptive—for the information that was being sought so it was replaced with slightly more open queries accompanied by suitable choices. For example:

Relating to your experience overall—did you find the time to view information reasonable?

○ I gave up—totally unusable

○ I had to wait too long for most of the information, but I persisted

○ I waited for most of the information, but it was Ok

○ I wasn't particularly aware of the wait

○ Fast and totally reasonable

⊙ No answer

Figure 28—Typical survey question

The "Future Use" section, however, employed a more conventional Likert-type scale and was presented as an array of sub questions.

Dependencies were set up between questions so that some of them were only shown where appropriate. For instance, the question "Have you ever scanned QR codes with your phone before?" was only seen if the user had previously answered "Yes" to the question "Did you have a QR code scanner installed on your phone

before visiting the (venue) and scanning the QR codes?" As with many of the decisions taken regarding the survey questions these dependencies were incorporated in order to keep the survey short.

5.4.3   Age ranges

The same, mutually exclusive, age ranges were used throughout all the surveys undertaken as part of this project to ensure meaningful comparisons between data sets. The ranges were:

- Up to 10
- 11 to 17
- 18 to 29
- 30 to 49
- 50 to 69
- 70 plus

These were selected to partially reflect the educational remit of this project—with the first three representing pre[90] and primary school combined, secondary school, and tertiary education respectively—and partially to keep the number of age ranges manageable. Obviously they are not equal in terms of years encompassed, but it was felt that there was little to gain in trying to predict peoples scanning habits based upon such an arbitrary factor as they're being a particular, precise age. In addition, as some age ranging whilst polling was likely to involve observation as opposed to direct questioning, it was felt that there would be less mis-categorisation using the fairly broad ranges at the end of the scale than if the ranges had been narrow.

5.4.4   Polls

In order to gather information regarding the reasons people did not scan QR codes and also to try and establish comparisons between published gate figures and footfall at the pilot sites two days of polling were undertaken, one day at each site. Two information gathering routines were carried out, a basic count and a poll. For the count the researcher stationed himself at opening time at the entrance/exit and counted people entering the pilot areas, recording observable information such as sex and age range (see discussion above re age ranges). The researcher stayed at this post until closing time (a 7 hour shift in the case of the Museum and 8 hours in the case of the Glasshouse).

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[90] It was felt that pre-schoolchildren were extremely unlikely to be "users" as far as this project was concerned and hence they didn't need a separate age band.

It should be noted that the Great Glasshouse has three entrances, only two of which can be seen by a single observer at any one time. However, observations and discussions with members of staff on previous occasions had established that the majority of people entered through one entrance and even those who hadn't tended to pass the one entrance shortly after entering. An attempt was made to count people by observation (most visitors appeared to have one or more easily observed distinguishing characteristics that, in theory, should have made it relatively easy to count them only once). In the event when the observed count was compared to the gate figures it appeared that more than 60 extra people had visited the Glasshouse than had been counted through the gate. It was inevitable that, given the method of reckoning, double counting would take place. However these figures would seem to indicate that approximately 25% (28% to be precise) MORE people were observed in the Glasshouse than came through the gate (and that assumes that everyone who came through the gate actually visited the Glasshouse[91]). Subsequent investigation turned up the fact that conferences and corporate visitors aren't counted through the gate and attendees often visit the Glasshouse. Fortunately, another measure of footfall in and around the Glasshouse was available (attendance in an exhibition area inside the glasshouse—the "From Another Kingdom" exhibition of fungi) and the original gate to observed visitors ratio (as discussed earlier and illustrated by Equation 1—Calculating the pilot sample size) could be replaced by a "From Another Kingdom" to observed visitors ratio.

For the "Did not scan" poll the researcher simply asked people as they departed from the Glasshouse if they had scanned a code. Those that had were thanked and the interview ended at that point. Those that hadn't were asked to select a statement from a list that best matched the reason they hadn't scanned (see Appendix 5—'Did not scan' poll questions). In some cases a supplemental question was asked (e.g. when the statement "I saw them, knew what they were, but didn't have a phone" was selected the follow up question "At all or just not with you" was sometimes asked). The supplemental questions weren't asked with any degree of consistency as the researcher was concentrating upon a statistically significant sample size for the primary questions rather than gathering incidental information which, though of interest, had no direct bearing upon the core research. The respondent's sex and approximate age were also recorded, both ascertained through observation. Some

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[91] According to staff at the Garden this is almost certainly the case.

people volunteered remarks about the project and, where possible, these were recorded.

This poll was never intended to capture the entire "Did not scan" population, merely a random sample. Thus for this poll the fact that people could leave through alternative exits had no bearing upon the result.

It should also be noted that, whilst the majority of the pilot phase took place in the school summer holidays, the poll/survey days were in term time. It's likely that this factor will have had an effect on the visitor demographic at the venues on the polling days, but it's not clear how much of an effect, nor just how it might skew the results. For instance, school visits to the Museum might actually increase the 11 to 17 count in term time. The polling/survey data wasn't of prime concern for achieving the overall aims of the project and this factor would be taken into account when accounting for the results.

5.5   Production systems

As discussed elsewhere, once the demonstrator/development version had done its job, the production versions of the system were created using clean install of Drupal and the key modules that allowed the system to function.

5.5.1   Museum Installation

5.5.1.1   Pre install survey

The object of the exercise when performing the pre installation survey was to:

- Identify possible QR code candidates
- Establish the existing level of information provision, especially in those areas where QR codes could be placed. This was intended to be more of a qualitative measure than a quantitive measure[92]

The information provision in the Insight gallery was a mixture of reasonable through to practically non-existent. The Cave Spider cabinet (which ultimately

Figure 29—the Spider cabinet in the Insight Gallery

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[92] Counting words on labels was thought to be a step too far.

became a QR code candidate) was fairly well served with not only reasonable comprehensive labels, but also an additional, adjacent panel showing some further information about the search for the cave spider. Combined, the two displays provided approximately a dozen short paragraphs of bilingual text (approximately 300

Figure 31—Cave spider information panel

words per language), slightly more images and a few physical specimens. It's interesting to compare this with the final QR code linked web information covering the same subject. Materials relating to the Cave Spider consisted of an additional 11 images and an additional 8 paragraphs of text (approximately 600 words per language). The information provision at the case was more than doubled by linking to a web resource.

By way of contrast, the Fish case (which also became a QR code candidate) had practically no related information at all. The jars had small hand written (and faded) labels and that was about it. Adding a QR code to this cabinet immediately allowed access to a "Who's Who" with 10 photos and over 300 words of explanatory text

All in all the following types of information layering were identified in the gallery:

- Images
- Text
- Video (via audio-visual workstations and display panels)
- Audio (via audio-visual workstations)
- Graphics panels
- Slide shows projected from ceiling mounted projectors
- Books
- Cased specimens
- Uncased specimens

Figure 30—The Fish case

5.5.1.2 Taxonomy for the Insight Gallery

After discussions with museum staff, 9 QR code sites were identified as follows:

- Cave spider
- Collections character
- Fish case
- Research character
- Seabed life
- Whitebeams
- Biological Taxonomy (character)
- Banded Snail
- Bird skins case

These gave rise to the following (relatively flat) Taxonomy:

Banded Snail	
Biological Taxonomy	
Bird skins case	
Cave Spider	
Collections Character	
Research Character	
Seabed Life	
↘	Seabed Life - general
↘	Seabed Life - kid
↘	Seabed Life - scientific
Whitebeams	
Fish case	

Table 1—Insight Gallery Taxonomy

5.5.1.3 Branding

The museum also provided branding guidelines and images to enable the web
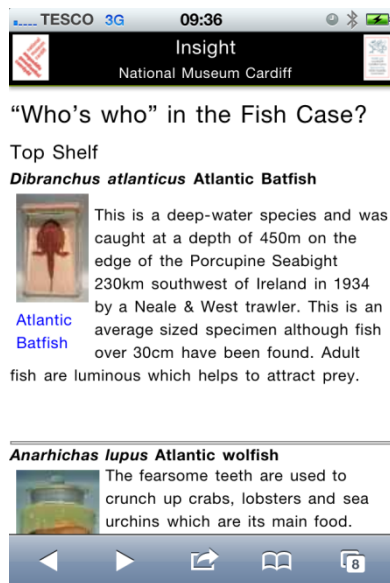
Figure 32—Original Museum branded template

materials to look similar to other Museum offerings (see Figure 32) and to help in the production of signs. Owing to last minute data protection issues—the museum decided that they didn't wish to be (or be perceived as) the data controller for any potentially personal

Figure 33—Final unbranded template

information gathered—some features of the branding (such as museum logos) were not used in the published template. Figure 33 shows the final version of the Museum template.

5.5.1.4 Installation

The QR codes used for the Museum were printed on lightweight card at an agreed 7 cm x 7 cm (including the required white border), marked on the back (in case they became detached and need to be identified without scanning), laminated and attached to cabinets and signs using agreed fixing methods[93]. Records were kept of the proposed installation sites, the associated long URLs and the two associated short URLs (see Appendix 8—QR Code Installation records). The museum provided two A3, portrait, freestanding signs for the "Welcome" and "Exit" signs (which they kindly printed as well) and these were placed at the entrance to the gallery. The installation was ready for use by the 14th of August (although a Sunday, the Museum is open on Sundays[94]). Data was collected over the period from the 14th of August through to the 8th of September.

Images of the codes in situ can be seen in Appendix 10—Final QR code positions.

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[93] Double sided tape on glass surfaces and rolled masking tape on other surfaces.
[94] The Museum is closed on Mondays (apart from Bank holiday Mondays, one of which occurred in the course of the pilot period). This factor was noted and taken into account when analysing the data.

5.5.2   National Botanic Garden Installation

5.5.2.1   Pre install survey

Unlike the Museum, where many of the artefacts were spaced out behind glass, the Great Glasshouse is in effect an actual oversized, crowded display cabinet in its own right with people walking around inside it, touching, smelling and interacting with the crowded specimens. The information environment is radically different both in terms of the space available and the connections that can be made between sign and plant.

Another problem that the Gardens faces is that, unlike museum displays, the Glasshouse is an environment populated with living and changing plants. Things get moved, die, or simply change quite radically with the seasons. It's difficult for the signs to keep up.[95]

Broadly speaking information provision in the Great Glasshouse at the Gardens fell into four general groupings (with a few miscellaneous others on top).

- **Plant labels**—equivalent perhaps to the small labels placed next to specimens in the Museum cabinets
- **Pedestal signs**—equivalent to the larger external cabinet signs in the museum that provide information about a group of specimens or specimens of particular interest.
- **Wall mounted displays**—areas where longer narratives can be encountered
- **Wall mounted Video displays**
- **Miscellaneous small signs**

Figure 34—Typical plant label

A significant aspect of the problem here is the very density of specimens encountered. Figure 34 shows a standard plant label with a display area typically in the order of 7cm x 10 cm and with three or four lines of information (common name, genus/species, habitat, and so on). The label can't really be much larger without encroaching upon the "territory" of adjacent plants. Indeed, many plants don't have labels at all for that self-same reason.

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[95] One of the QR coded plants used for the pilot was little more than a cut off stem at the time of installation.

Figure 35—"Special interest" plant sign

Occasionally a plant of special interest has a supplementary large pedestal style sign with additional information. Typically these will be bi-lingual with three or four paragraphs of information and two or three extra photographs. Figure 35 shows a typical example (and also shows a typical plant label beneath giving some idea of the differences between the two sizes). However, these extra signs are few and far between (the researcher counted 5 in the entire glasshouse). Again space is a problem and on occasion these signs are not immediately adjacent to the plants in question.

The next level of signage is perforce another step removed from the plants they are connected to. These pedestal style signs give information about larger group of plants—common characteristics, habitat and so on—and cover significant areas within the glasshouse. Some provide maps and "you are here" style information. Figure 36 shows a typical example. On the whole they have 4 or five paragraphs of bi-lingual text and two or three images. The researcher counted 10 such signs in the glass house.

Figure 36—Area pedestal sign

Figure 37—Wall mounted display panel

The wall mounted panels offer a significantly larger area for displaying information. However, there is only one wall in the glasshouse suitable for such displays and this means that once again the information offered up to the visitor is totally divorced from the plants being described[96]. The researcher counted nine

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[96] Generally these panels are used to describe the main regions and the glasshouse itself.

Figure 38—Video display screen

such panels each with typically three to five "blocks" of text per language (Figure 37 shows a typical panel and the "blocks" that it's made up of) and ten to twelve images.

There are two wall mounted video screens, one at each end of the Glasshouse[97], each showing informational videos. These are not particularly visible or well frequented (see Figure 38). On visits to the Glasshouse it was observed that few if any people even saw the screens, let alone stopped to view them.

Other miscellaneous signs and information provision include:

- Carved stone territory markers (Australia, Canary Islands and so on)
- Oversized plant labels—similar to the standard plant label but twice the size and with a paragraph of text and small image. Very few of these were encountered
- Plant tape labels—either attached to the plant or on a small plastic stake next to the plant. These are similar to those encountered in many garden centres and probably not intended for "public" consumption
- Marker signs—these appeared to be associated with a Garden wide plant trail (Plants and Climate Change). Only a few were encountered.
- Trail printing booth—(see Figure 39). This booth allows people to pay to print out a paper copy of one of three "Trails"[98] that describe plants in the Glasshouse. It does not appear to be well used (if at all—the researcher didn't observe a single print transaction in all the visits made to the Glasshouse and staff have intimated that it is rarely used).

Figure 39—"Trail" printing booth

5.5.2.2   Taxonomy for the Great Glasshouse

After discussions with staff at the gardens it was agreed to base the pilot project around the trails mentioned above. These describe the use of plants in three different scenarios: Their use in survival and hunting situations (the Survival Trail),

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[97] They are at the extremes of the visitor concourse—to all intents and purposes stuck away in a corner— and have no passing footfall.
[98] Ecology trail, Sensory trail and Survival trail

aromatic plants (the Sensory Trail), and plants that live in the narrow Mediterranean like climate regions around the world (the Ecology Trail). These trails gave rise to 23 QR code sites—mainly associated with individual plants but some also encompassing generic areas—as follows:

- Cape reeds
- Erica caffra
- Mountain Laurel forests
- Chaparral
- Grevillea maccutcheonii
- Hakeas and banksias
- Puya
- Euphorbias and aeoniums
- Rosemary (and lavender, myrtle)
- King protea
- Leucadendron
- Watsonia
- Lavender
- Teline stenopetala
- Pelargonium papilionaceum
- Boronia heterophylla
- Californian Sagebush
- Ñipa tree
- White Sage
- Sagebush
- Columbine
- Grass tree
- Wattle tree

These gave rise to the following taxonomy:

Ecology	
↘	Cape reeds
↘	Erica caffra
↘	Mountain Laurel forests
↘	Chaparral
↘	Grevillea maccutcheonii

↘	Hakeas and banksias
↘	Puya
↘	Euphorbias and aeoniums
↘	Rosemary (and lavender, myrtle)
↘	King protea
↘	Leucadendron
↘	Watsonia
Sensory	
↘	Lavender
↘	Pelargonium papilionaceum
↘	Boronia heterophylla
↘	Californian
↘	Ñipa tree
↘	Teline stenopetala
Survival	
↘	White Sage
↘	Sagebush
↘	Columbine
↘	Grass tree
↘	Wattle tree

Table 2—Great Glasshouse Taxonomy

5.5.2.3 Branding

The Garden had little to offer in the way of branding guidelines so a decision was made to emulate the branding on their web page (with appropriate adaptations for use on smartphones). This decision was subsequently ratified by the Garden.

Figure 40 shows a sample of the finished template.

5.5.2.4 Installation

The QR codes used for the Gardens were printed on lightweight card at an agreed 10 cm x 10 cm, marked on the back (in case they became detached and need to be identified without scanning), laminated and attached to standard plant label spikes with double sided tape.

Figure 40—Example of the final version of the Botanic Garden template

These spikes were then hammered into the ground (generally by first opening up a hole using a steel spike—the ground in the Glasshouse was found to be particularly hard) or attached to suitable barriers adjacent to the points of interest. Records were kept of the proposed installation sites, the associated long URLs and the two associated short URLs (see Appendix 8—QR Code Installation records).

The Gardens were unable to supply freestanding sign holders for the Entry and Exit signs so the researcher designed and manufactured these[99]. Three signs were made (one for each entrance), each holding three A4 notices, two facing forwards—the Welsh and English versions of the "Welcome" signs—and one facing to the rear and visible on exiting the Glasshouse—a combined Welsh and English "Exit" sign. Figure 22—Welcome sign in situ in the Great Glasshouse on page 51 shows one of the completed sign holders. The signs were placed at each entrance such that they were clearly visible to all people entering and leaving the Glasshouse.

The codes were installed on the 18th of August—a day later than planned owing to an incident with a drill bit that necessitated a visit to casualty—and were ready for use by the 19th. Data was collected over the period from the 19th of August through to the 8th of September.

Images of the codes in situ can be seen in Appendix 10—Final QR code positions.

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[99] Using Ikea speaker stands, Ikea picture frames, aluminium angle strip and aluminium box section.

Chapter 6—Data analysis

6.1   Parameters

Two pilot projects were undertaken in the period 14th August to the 8th September
2011[100] at two different locations, the Insight Gallery in the National Museum Cardiff
and the Great Glasshouse at the National Botanic Garden Wales in Llanarthne,
Carmarthenshire.

The two locations proved a number of interesting contrasts

	National Museum	**Botanic Garden**
Pilot area	Insight Gallery	Great Glasshouse
Location	Urban (centre of Cardiff)	Rural (in the Camarthenshire countryside)
3G signal	Generally good	Generally poor
WI-FI	Unavailable[101]	Free public access
Demographic	Generally younger	Generally older

Table 3—Pilot venue characteristics

The pilot at the National Museum ran from the 14th of August to the 8th of September.

The pilot at the Botanic garden ran from the 19th of August to the 8th of September.

6.2   Repurposing

Although not the core aspect of the research this is perhaps the simplest datum to
analyse and draw conclusions from. All web nodes[102] created using materials
supplied from existing resources and re-purposed for use in this system were
assigned to a user labelled "Re-purposed". Table 4 and Table 5 below show the
word and node counts for users[103] on the two pilot sites.

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[100] From the 19th August at the Botanic Garden
[101] It should be noted that a wireless network did become available towards the end of pilot.
[102] In Drupal nomenclature a "node" is block of content (text, images, etc) that is addressed as a single unit and which generally forms a single web page. Although nodes can be combined to produce a single web page output using various techniques that has not been done here so to all intents and purposes, for this project, "node" equates to a web page.
[103] In this context the user Anonymous has been used to "own" nodes that are not published and have been left in place as part of the audit trail for the site and which fall outside of the remit of this research.

Word count—Botanic Garden

name	nodes	words in nodes	words per node	total words
Anonymous	4	5	1.3	5
PaulS	20	3486	174.3	3486
Re-purposed	67	8090	120.7	8090

Table 4—Word and node counts from the Botanic Gardens

Word count—National Museum

name	nodes	words in nodes	words per node	total words
Anonymous	3	298	99.3	298
PaulS	20	3466	173.3	3466
Re-purposed	57	16238	284.9	16238

Table 5—Word and node counts from the National Museum

Taking a simple approach, in terms of nodes and/or word count it is clear that re-purposed content significantly outweighs original content. This significance is all the greater when one takes into account the fact that all of the content assigned to user PaulS relates to pages describing the project. It's true to say that this type of "glue" will always be required and is likely to be original material, but, once produced, it is unlikely to be added to as new content is incorporated. In effect, the larger the project smaller it will become in overall percentage terms.
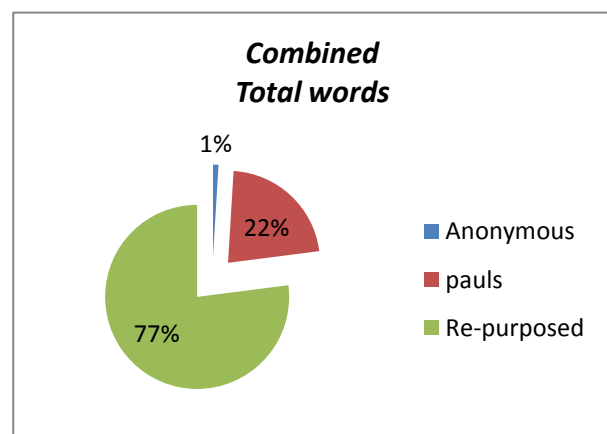
Figure 41—Repurposed versus Original word counts

Looking at the figures in terms of percentages of words, 81% of the text based content used in the Museum pilot was repurposed and 70% of the text based content used in the Gardens pilot—the gardens site ended up with a high graphics to word count which goes some way towards explaining the difference—was repurposed. The combined figures give rise to 77% repurposed text based content (Figure 41—Repurposed versus Original word counts)

The imagery content[104] is even more significant. 100% of the pictures, movies, PowerPoint presentations and PDF files used on the Museum site were provided from existing sources by the Museum. The Gardens provided 87% of the images used in the Gardens pilot. The other 13% mainly related to images taken to illustrate the vistas users were intended to see in the Glasshouse. 94% of the combined imagery used in both pilots was re-purposed.

Obviously repurposing is not just about the source of materials. There's an element of time involved as well, especially when the process involves moving content from one system to another manually as was the case for these pilots. In an ideal world a system such as that developed in this project would be fully integrated into a venues main web server and database, accessing the content directly via the back-end, with appropriate formatting and media processing being done on the fly with little or no manual intervention. Taken to its extreme, on the assumption that such a system would exist on a full-sized rollout, there is an argument to say the simple counts above *are* sufficient. The only cost would be for the original content and the "glue" pages. However, in order to allow readers to make a value judgement for their own situations the times involved in the manual process are discussed here as well.

It's difficult to quantify the time per node for, although the overall hours taken to develop and populate the systems were recorded, there was no differentiation between system development (which included amongst other things elements of research, coding, and systems maintenance) and the repurposing (which also had elements of experimentation and research in the early stages until a satisfactory work flow was established). However, taking these factors into account, in the later stages of node generation through repurposing it was taking between 10 and 15 minutes per page to take the "raw" text, translated text, unaltered images and any associated files from "start" to "published".

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[104] In this context imagery has been taken to include pictures, PDFs, Movies and PowerPoint presentations.

For those who insist upon monetisation, using a base hourly rate of £13.74 per hour[105] gives a cost per node to repurpose with this system of £3.43. This gives a total (estimated) cost of repurposing the Museum content of £195 and £230 for the Botanic Garden.

The cost of original material is harder to estimate. Erring on the side of caution we could assume that each original node would take skilled content professionals 2 hours to create from scratch (including translation). Using a base hourly rate of £21.97 per hour[106] we have a cost per original node of £43.96. Both the Museum and the Garden have the same number of original nodes, 20, costing a total of £879 each.

The cost per code scanned *over the pilot* period using these arbitrary figures is £1.58.

Or in user terms the cost per unique user *over the pilot period* could be estimated as a little over £7.

However, that is all an upfront cost. The only running costs are those of maintaining a web server, something that both venues (and most if not all target institutions) do anyway. So it could be argued that the cost per unique visitor is ever decreasing.

Even with the current type of system the cost of repurposed nodes will fall as more productivity tools are added.

6.3   Sample sizes

Three types of sample were used in the project, estimated (calculated), randomly selected (and hence an exact sample size would be known when drawing conclusions) and self-selected (also known).

6.3.1   Overall footfall

Based upon observation and figures provided by the museum the ratio of footfall in the Insight Gallery versus the footfall in the Natural History section is 304:535. In other words 56.8% of the people who entered the Natural History section penetrated as far as the Insight Gallery. Extrapolating from this figure (and again using gate

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[105] £25,000 per annum, over 52 weeks at 35 hours per week. Obviously this doesn't take into account the on costs, heat light, server,etc.
[106] £40,000 per annum, over 52 weeks at 35 hours per week—professional generators of original content get paid more than cut and pasters. Again this doesn't take into account the on costs

figures supplied by the Museum) the estimated number of people who were "exposed" to QR codes in the gallery over the pilot period was approximately 9,620.

The calculation of the Glasshouse footfall at the Botanic Garden was not quite so straightforward (see the discussion in 5.4.4 Polls on page 56). However, based upon observation and figures provided by the Gardens the ratio of footfall in the Glasshouse versus the footfall in the "From another Kingdom" (FAK) exhibition section is 268:340. In other words 78.8% of the people who entered the "From another Kingdom" exhibition were exposed to QR codes in the Glasshouse. Extrapolating from this figure (and again using gate figures supplied by the Gardens) the estimated number of people who were exposed to QR codes in the Glasshouse over the pilot period was approximately 9,645.[107]

6.3.2   Other sample sizes

The "Did not scan" poll took place on the 6th of September in the Great Glasshouse at the Botanic Garden over a period of 8 hours (from opening to closing time). In that period 131 people were quizzed about the reasons they didn't scan a code

A similar poll took place on the 7th of September in the Insight Gallery in the Museum over a period of 7 hours (from opening to closing time). In that period 150 people were quizzed about the reasons they didn't scan a code.

In the period between the 13th of August[108] and the 8th of September 12 "Welcome" surveys and 8 "Exit" surveys (plus 2 uncompleted surveys) were submitted in the Insight Gallery.

In the period between the 19th of August and the 8th of September 44 "Welcome" surveys and 22 "Exit" surveys (plus 5 uncompleted surveys) were submitted in the Great Glasshouse.

6.4   User perceptions—survey results

It should be noted when considering these results that, apart from those users polled face to face, all participants in these surveys were self- selecting. In addition, they

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[107] The FAK exhibition is entirely within the Glasshouse. People can enter and leave at will and are automatically counted. In figures collected by the Garden it is regularly shown—85% of the time in figures available—that more people have entered the exhibition than have entered the garden through the main gate. As it is within the Glasshouse, using the FAK ratio was thought to provide a better estimate of overall footfall in the Glasshouse than the ratio based upon the main gate figures. In the event the figure calculated is 90% of the recoded main gate entry which matches quite closely anecdotal reporting of main gate to Glasshouse figures.
[108] The Signs had been put in place in the Gallery by museum staff on the evening of the 12th in anticipation of the installation on the 13th. One user scanned the sign before the installation actually took place.

had first to scan a QR code before they could even reach the surveys which means that by definition they were a) QR code scanners, and b) felt strongly enough about their experiences to comment upon them.[109]

6.4.1 "Welcome" survey

This was the briefest of the surveys and was intended to gather basic demographic data. It was designed to be as quick to fill in as possible, to introduce users to the fact that the data was being gathered for research purposes and to get them "primed" into survey mode for their final survey.

As the survey samples were relatively small there is little that can be reliably concluded from these results. However, they are included for completeness. Table 6 shows the results from the Museum, Table 7 the results from the Botanic Garden and Table 8 the combined results

Q	responses	
1	**How old are you?**	
	11 to 17	2
	18 to 29	7
	30 to 49	3
2	**Male or female?**	
	Male	9
	Female	3
3	**Where are you from?**	
	South Wales	6
	UK	3
	Europe	1
	USA	1
	Asia	1

Table 6—Welcome survey—National Museum

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[109] There were, however, clear signs mentioning the prize draw which may have helped to draw them in.

Q   responses

1 How old are you?	
Up to 10	2
18 to 29	11
30 to 49	21
50 to 69	9
70 plus	1
2 Male or female?	
Male	27
Female	17
3 Where do you live?	
South Wales	24
UK	20

Table 7—Welcome survey—Botanic Garden

Q	responses	NM	NBGW	Totals
1	**How old are you?**			
	Up to 10		2	2
	11 to 17	2		2
	18 to 29	7	11	18
	30 to 49	3	21	24
	50 to 70		9	9
	70 +		1	1
2	**Male or female?**			
	Male	9	27	36
	Female	3	17	20
3	**Where are you from?**			
	South Wales	6	24	30
	UK	3	20	23
	Europe	1		1
	USA	1		1
	Asia	1		1

Table 8—Welcome survey—Combined results

6.4.2 "Exit" Survey

The "exit" survey generated some of the more interesting results. It should be noted that a minority of surveys at each site were only partially finished. Where appropriate these partial surveys were included in the results as well. Also, users were not obliged to enter a response for any of the questions. "No answer" is the response when a user has skipped past a question (it's the default response). "Not completed" is the response for questions that have not been reached (because the user failed to finish the survey or because the answer to a previous question caused the survey to branch past that question).

6.4.2.1 Hardware and software

Starting with the hardware and software the first questions asked related to prior use. Users were asked if they had a scanner installed (*Did you have a QR code scanner installed on your phone before visiting the (venue)*

Did you have a QR code scanner installed on your phone before visiting the (venue) and scanning the QR codes?

No answer, 5%

Not completed, 0%

No, 35%

Yes, 60%

- Yes
- No
- No answer
- Not completed
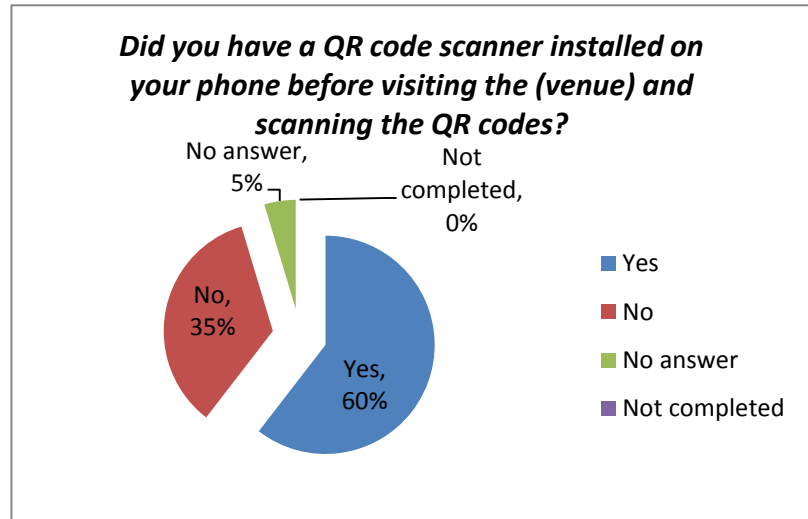
Figure 42—Pre-installed scanne rdata

and scanning the QR codes?*) and if they had scanned codes before (*Had you ever scanned QR codes with your phone before?*[110]). 35% of combined users said that they hadn't a scanner installed prior to their visit, they were complete scanning virgins. This result implies that they must have downloaded a scanner on the spot (obviously they were now scanning QR codes as they couldn't have reached the survey without going through the code link). Many users are reportedly wary of downloading apps via their mobile network because of the possible impact such a download may have on their data quota (indeed, Apple go so far as to suggest to users that they only install apps using a WI-FI connection or through iTunes) so this result is perhaps a little surprising (or perhaps not when you consider how many people *didn't* download on the spot). A closer examination of the differences between the data from the two pilots shows that none of the respondents from the museum (which had no wireless connection) downloaded "on the spot". All the installations immediately prior to use took place at the Gardens which not only had a wireless network in the greenhouse, but also advertised the fact on the "Welcome" signs. It would appear that users were taking Apples advice to heart. It would also appear that having a freely available wireless network makes a significant impact on the uptake of the service by new users.   As one user comment put it "Provide free wifi so that the online experience works".

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[110] This question wasn't asked of those who answered "No" to the first question. It was assumed that their answer to this question would also be no and could safely be added on to the "No" column.

The question relating to prior use is a little more problematic as far as drawing conclusions is concerned. On the face of it only 7% of people hadn't scanned before. However, answering no the previous question would give a "Not completed" answer here. So the true figure is probably closer to 35%. On the other hand, over 50% of people had

Had you ever scanned QR codes with your phone before?

Not completed, 28%

Yes, 51%

No answer, 14%

No, 7%

- Yes
- No
- No answer
- Not completed
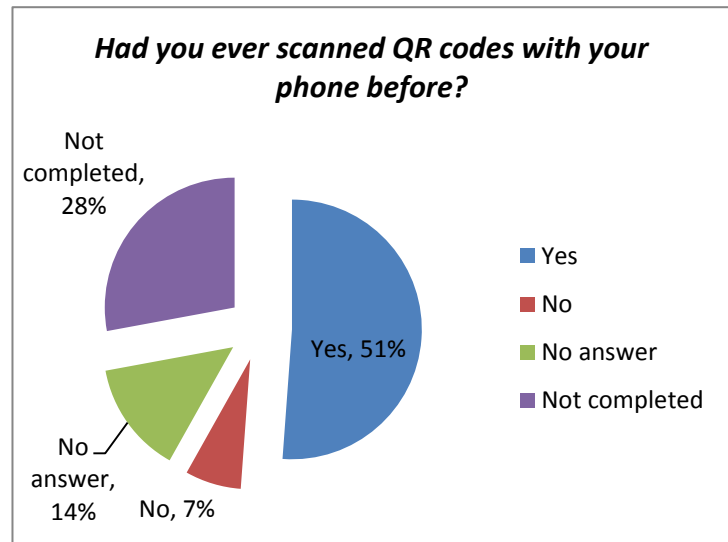
Figure 43—Prior QR code scans

scanned before. Again, not really surprising as prior use is likely to be a strong factor in influencing people to scan codes again (as long as the prior use was a positive experience). Breaking out the figures for prior use ("Yes") on a venue by venue basis shows a slight bias in favour of the Museum (62% yes versus 47% yes) which can perhaps be explained by the generally younger demographic.

The questions that followed re mobile networks, wireless versus mobile data connection and 3G use are of less immediate interest. Indeed, the network connection questions may even have been too technical in nature for it is apparent that some users
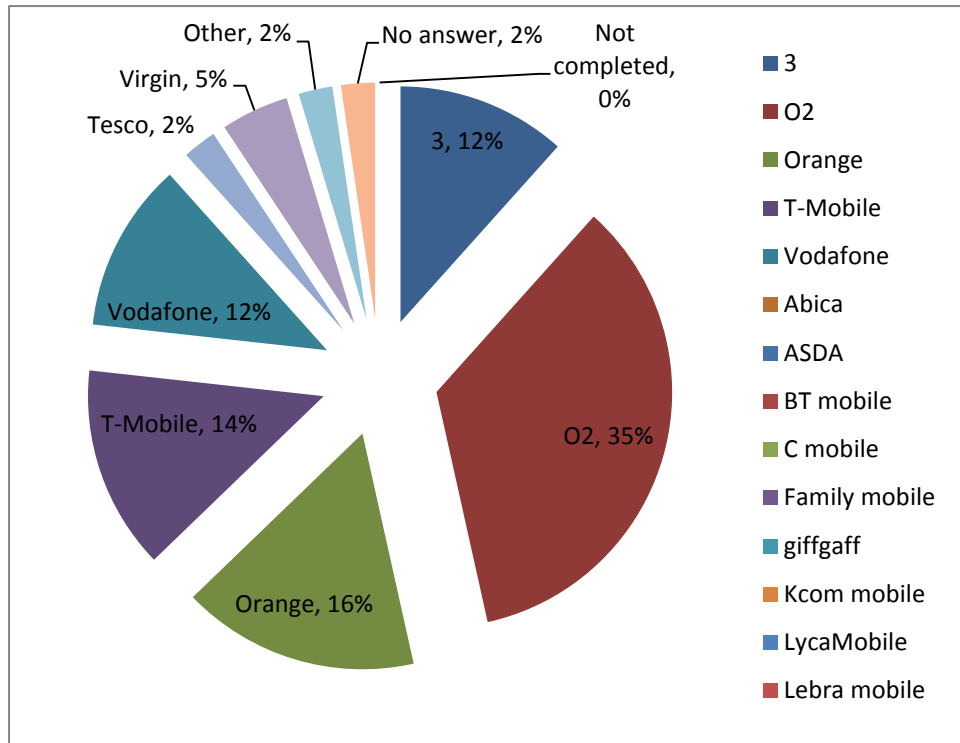
Figure 44—Mobile network

weren't truly aware of the true nature of their connection. For instance, at the Gardens, 40% of users said that they had been using a 3G connection, but only 13% said they used Vodafone, the only network in that area known to be capable of a 3G connection (and even then intermittently). What's more likely is that their phones were set-up to connect to open wireless networks and did so in the Glasshouse without the users being aware of the fact. The subsequent speedy performance was then attributed to 3G.

The final question in this section related to ownership of the scanning phone. 95% of the respondents said that they owned the phone they used to scan (the other 5% were "No answers".

6.4.2.2 Perceptions and satisfaction

It's probably fair to say that those who used the service were happy or even very happy with their results.

On a scale of 1 to 5—relating to your experience overall—did you find the time to view information reasonable?

Not completed, 5%
I gave up—totally unusable, 0%
No answer, 5%
I had to wait too long for most of the information, but I persisted, 9%
Fast and totally reasonable, 37%
I waited for most of the information, but it was Ok, 21%
I wasn't particularly aware of the wait, 23%

- I gave up—totally unusable
- I had to wait too long for most of the information, but I persisted
- I waited for most of the information, but it was Ok
- I wasn't particularly aware of the wait
- Fast and totally reasonable
- No answer
- Not completed

Figure 45—Data download time satisfaction

For instance, only 9% thought that the wait time to download was too long (and no one gave up—which is to be expected as anyone giving up would probably not have made it as far as the survey to express that opinion) as seen in Figure 45—Data download time satisfaction. Comparing the two venues once again the museum, with no wireless network, generated more dissatisfaction, 15% as opposed to the Gardens 7%.

On a scale of 1 to 5—relating to your experience overall and your information expectations/wants—did you find the information you viewed relevant to the artefacts you were viewing at the time?

Not completed, 5%
No answer, 9%
Totally irrelevant, 9%
Partially relevant, 7%
Neither totally relevant nor totally irrelevant, 5%
Totally relevant, 37%
Mostly relevant, 28%

- Totally irrelevant
- Partially relevant
- Neither totally relevant nor totally irrelevant
- Mostly relevant
- Totally relevant

Figure 46—Relevance of web information

The satisfaction theme continues with the question relating to the relevance of the materials. Only 16% of the survey respondents found the information either partially or totally irrelevant. In this case the dissatisfaction was fairly evenly spread over both of the venues. And to be fair, the content selected for these pilot projects wasn't carefully selected or prepared with any particular audience in mind. It was selected on the basis of what was readily available at very short notice. It is then perhaps surprising that this dissatisfaction rating is so low (or perhaps a reflection on the excellent quality of materials generated by the staff at the two venues).

On a scale of 1 to 5—relating to your experience overall—would you say that the use of QR codes enhanced your experience in the Insight Gallery

- Detracted from my experience
- I got something out of it, but not much
- Neither enhanced nor detracted
- It was good, but could be better
- Enhanced my experience a great deal
- No answer
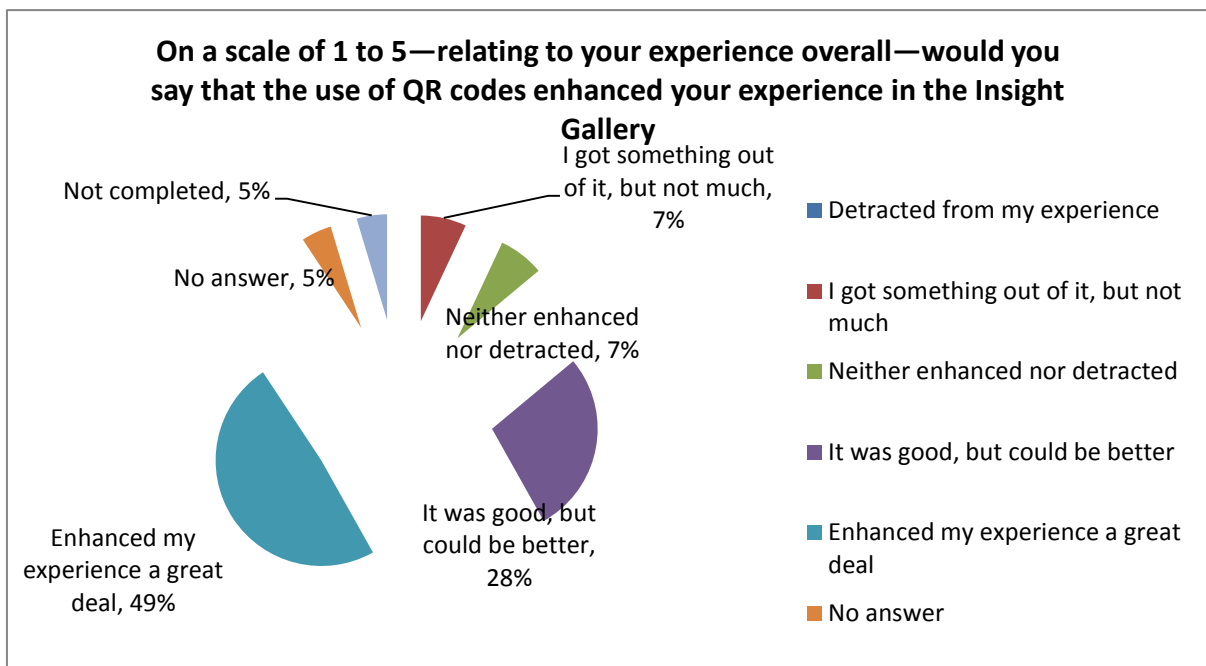
Figure 47—Perceived benefit

The next two datasets are perhaps the most pleasing of all. 49% of users across the two venues said that the system enhanced their experience a great deal (Figure 47—Perceived benefit) and 91% of users said that they would use the system again in similar situations (No one said no. The remaining 9% were "No answer" and skipped)—See Figure 48—Future use.
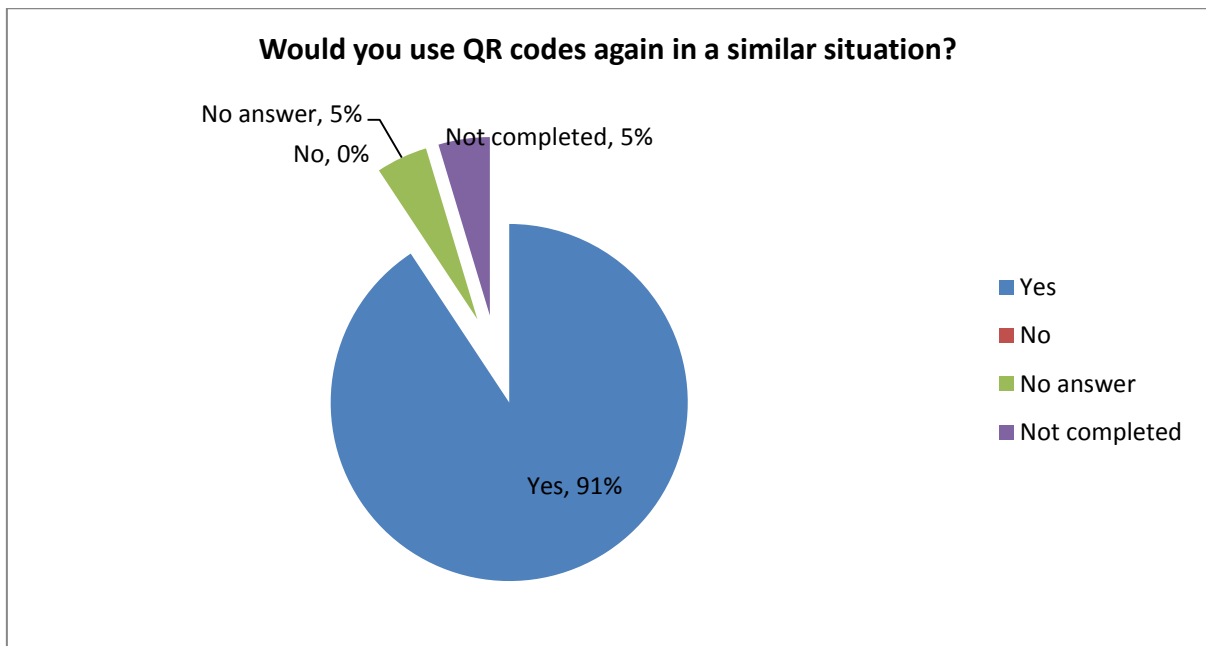
Figure 48—Future use

This satisfaction is reflected in their comments some of which are reproduced below.

"i was surprised at how easy it was to use. It would be great to see it extended to the whole of the gardens... …i would use it again…"

"I think this is an excellent idea"

"Very impressed."

"Been meaning to get the scanner app but never gor round to it till today! Was deffo worth it."

"Great info on scans …."

"… I'm happy to see them here."

" Nice idea for a project …"

It would appear that, as far as the people who actually got as far as scanning are concerned, the project was a resounding success!

It is interesting to note that, despite the significant difference in the age demographic of people who visited the two venues (as observed when undertaking the two on-site polls), the significant majority of scanners at both venues (and each venue on its own) were in the 30 to 49 age group both collectively and individually with the two

bracketing age groups (18 to 29 and 50 to 69) being evenly matched either side. Indeed the distribution resembles a classic bell curve.
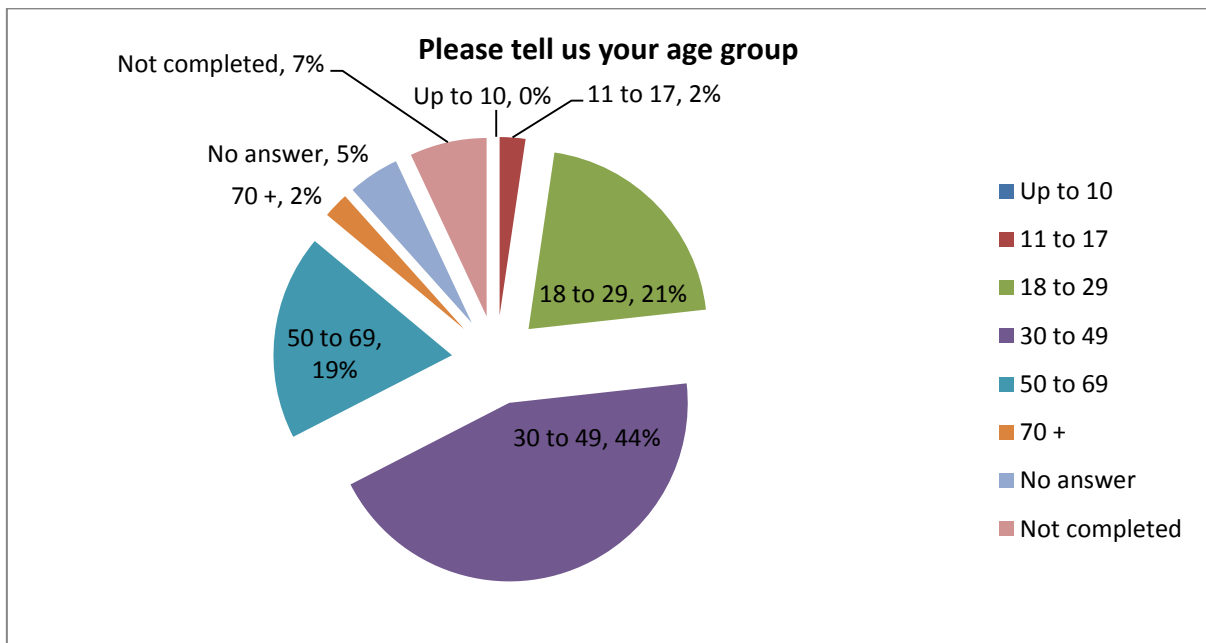
Figure 49—Demographic data—Age

The reasons for this observed datum are not clear (and the surveys and polls were not specifically designed to draw it out). Further research to establish this reason could form the bases of an additional project. Similarly, although it was observed that the majority (60%) of the scanners we male (compared to a starting position of relatively evenly matched) further study will be warranted to establish why.

Additional information such as that appertaining to the facility to bookmark pages, download information and that relating to alternative scanning activities—which was collected for the partners in the project—is listed in the appendices for completeness but again doesn't have any direct bearing on the essential outcomes of this research.

6.4.3 "Did not scan" poll

The "did not scan" polls were quite illuminating, not the least for the comments that were passed on to the researcher.

The tables below show the results in two forms—age centric and then sex centric—Followed by a graphical representation of the data.

Row Labels	Count of I didn't see codes	Count of I saw them but didn't know what they were	Count of I saw them, knew what they were, but didn't have a phone	Count of I saw them, knew what they were, but my phone can't scan	Count of I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/ signal	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan
up to 10		3					
F		3					
18 to 29		1	1	3	2		
F		1	1	2	1		
M				1	1		
30 to 49	2	7	3	6	2		
F	2	4	1	4	2		
M		3	2	2			
50 to 69	3	55	13	21	3		
F	2	34	5	13	1		
M	1	21	8	8	2		
70 plus		6					
F		1					
M		5					
Grand Total	5	72	17	30	7		

Table 9—"did not scan" information by age—Botanic Garden

Row Labels	Count of I didn't see codes	Count of I saw them but didn't know what they were	Count of I saw them, knew what they were, but didn't have a phone	Count of I saw them, knew what they were, but my phone can't scan	Count of I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/signal	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan
F	4	43	7	19	4		
up to 10		3					
18 to 29		1	1	2	1		
30 to 49	2	4	1	4	2		
50 to 69	2	34	5	13	1		
70 plus		1					
M	1	29	10	11	3		
18 to 29				1	1		
30 to 49		3	2	2			
50 to 69	1	21	8	8	2		
70 plus		5					
Grand Total	5	72	17	30	7		

Table 10—"did not scan" information by sex—Botanic Garden

Row Labels	Count of I didn't see codes	Count of I saw them but didn't know what they were	Count of I saw them, knew what they were, but didn't have a phone	Count of I saw them, knew what they were, but my phone can't scan	Count of I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/signal	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan
11 to 17	**12**	**11**		**8**	**3**	**3**	**1**
F	2	7		6	2	1	1
M	10	4		2	1	2	
18 to 29	**30**	**5**	**4**	**10**	**5**	**3**	
F	17	3	2	5	2	2	
M	13	2	2	5	3	1	
30 to 49	**16**	**6**	**2**	**4**	**1**		**2**
F	9	4	1	3			2
M	7	2	1	1	1		
50 to 69	**19**	**2**		**3**			
F	10	2		1			
M	9			2			
Grand Total	**77**	**24**	**6**	**25**	**9**	**6**	**3**

Table 11—"did not scan" information by age—National museum

Row Labels	Count of I didn't see codes	Count of I saw them but didn't know what they were	Count of I saw them, knew what they were, but didn't have a phone	Count of I saw them, knew what they were, but my phone can't scan	Count of I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/signal	Count of I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan
F	38	16	3	15	4	3	3
11 to 17	2	7		6	2	1	1
18 to 29	17	3	2	5	2	2	
30 to 49	9	4	1	3			2
50 to 69	10	2		1			
M	39	8	3	10	5	3	
11 to 17	10	4		2	1	2	
18 to 29	13	2	2	5	3	1	
30 to 49	7	2	1	1	1		
50 to 69	9			2			
Grand Total	77	24	6	25	9	6	3

Table 12—"did not scan" information by sex—National museum
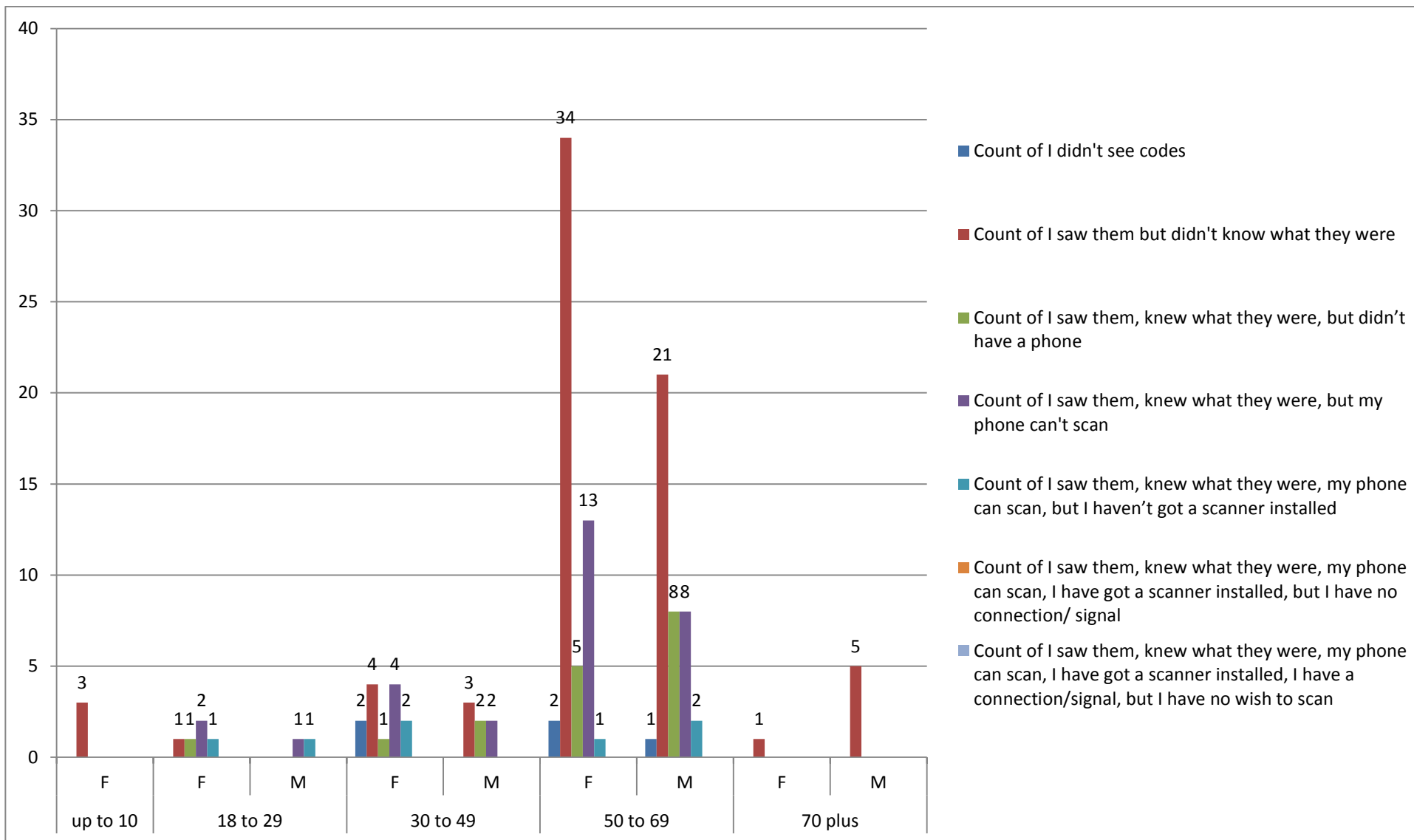
Figure 50—"Did not scan"—National Botanic Garden
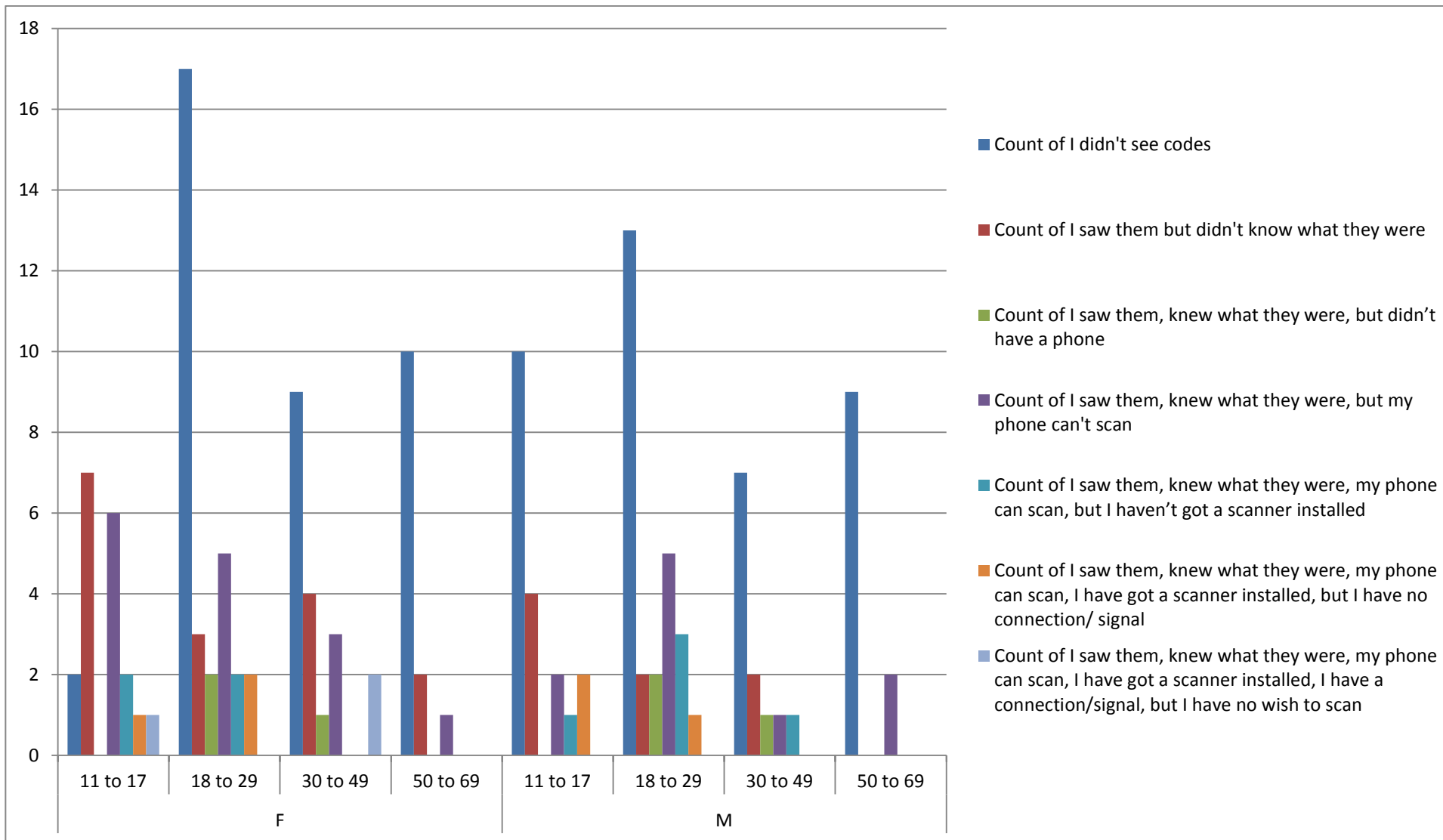
Figure 51—"Did not scan"—National Museum

So what does this information tell us? Well, on the face of it, people are not very observant, at least the people at the Museum that is. Despite large signs at the entrances saying what they were and prominently displayed QR codes the majority of people at the Museum who didn't scan reported that "Not seeing them" was the reason. At the Botanic Garden the predominant reason was "Didn't know what they were". Delving a little deeper, the reasons for this are not as straight forward as it might seem. Firstly, the QR codes at the Gardens were twice the size of those in the Museum. In addition, they stood out against the background and when compared to the other signs in the Glasshouse. The codes in the Museum certainly weren't as prominent in comparison. Comments from users at the Museum also shed some light on the matter. *"I thought they were something to do with the museum"*. People are now used to seeing codes on everything from vegetables to parcels. It would appear that theses codes have become invisible to all but those primed to look for them (the checkout person or the mail sorter for instance). If a code is observed on an artefact, unless the viewer is expecting it and knows what it's for, it is assumed that it's part of the museums cataloguing system and thus of no interest.

How can this be overcome? Bigger codes? Calls to action ("**Scan me!**")? Awareness raising (signs in the foyer, information on the web site, clearer signs at the gallery entrances)? Probably a combination of all of the above.

An additional factor that may have had some effect is that of institutional "respect". Many older people have always thought of museums of places of quiet reflection (the "Silence" sign and the attendant telling you to "Be quiet" are a stereotype that is practically engrained into the older generation's collective consciousness). Despite strenuous efforts on the part of museums to make themselves into places of interaction with the artefacts it is still hard for such a user pull out a phone to take a photograph let alone use it to communicate (especially if an attendant is in the vicinity). The younger generation don't appear to have the same inhibitions. In the course of site visits several younger people were observed taking photos, texting and in one case even talking on the phone.

Another factor that becomes apparent is that some people believe that their phones are incapable of scanning ("*You need an iPhone for that*"). In some cases this would appear to be a misguided belief. Subsequent probing led to the conclusion that their phone could scan, they simple didn't realise the fact.
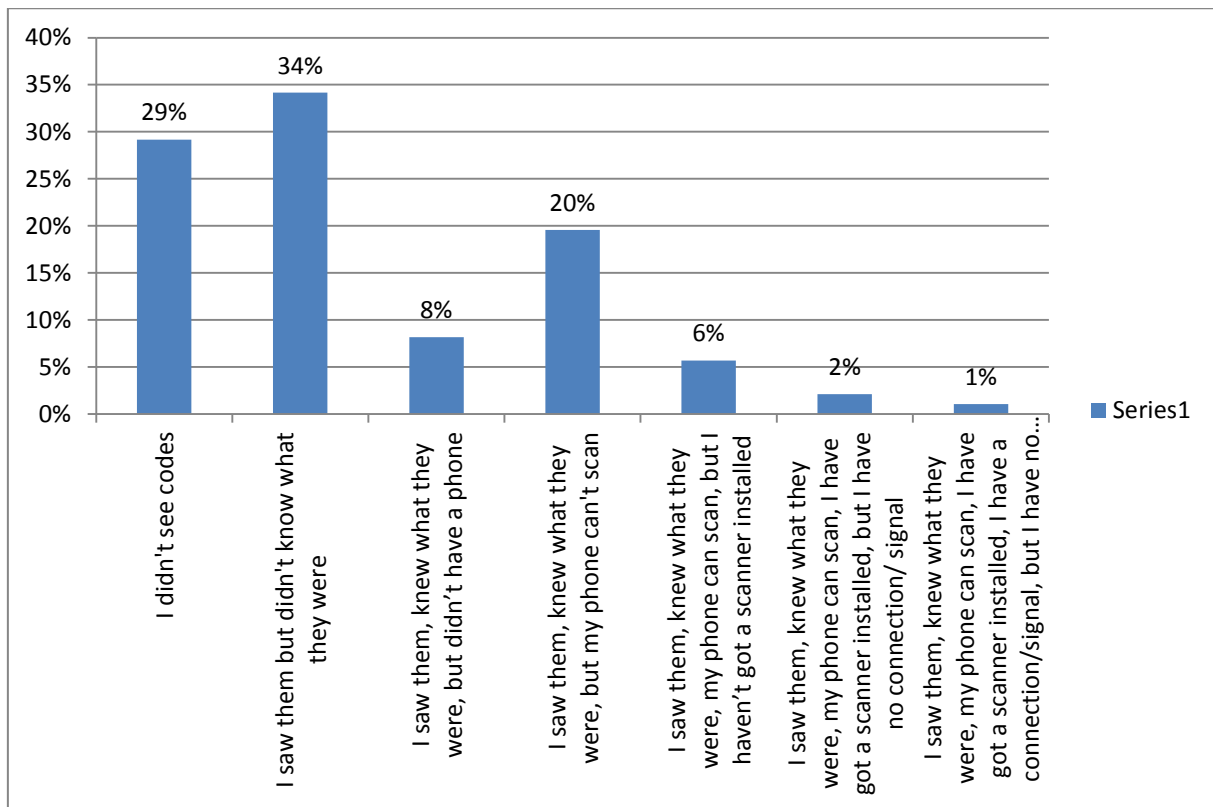
Figure 52—Combined "did not scan" results

The final significant point of interest is the number of people who didn't scan, but were aware of what QR codes were. 37% of those asked who didn't scan were aware of codes and their function ("I saw them, knew what they were…."). These people could possibly be persuaded to scan relatively easily, especially if wireless networks were available and scan downloads facilitated. The author would argue that this is a fairly high awareness and warrants further investment.

6.4.4   User count and demographic

The user demography was established as part of the poll undertaken at each site.

Table 13 and Table 14 show the raw results along with the associated percentages.

Date	07-Sep-11										
Location: National Museum Cardiff											
Male						Female					
up to 10	11 to 17	18 to 29	30 to 49	50 to 69	70 plus	up to 10	11 to 17	18 to 29	30 to 49	50 to 69	70 plus
25	26	41	27	29	0	27	30	47	30	22	0
8.2%	8.6%	13.5%	8.9%	9.5%	0.0%	8.9%	9.9%	15.5%	9.9%	7.2%	0.0%
Total male		148	49%								
Total female		156	51%								
Total overall		304									

Table 13—Demographic information—Insight Gallery

Date	06-Sep-11										
Location: National Botanic Garden											
Male						Female					
up to 10	11 to 17	18 to 29	30 to 49	50 to 69	70 plus	up to 10	11 to 17	18 to 29	30 to 49	50 to 69	70 plus
2	0	7	16	90	6	5	0	15	19	106	2
0.7%	0.0%	2.6%	6.0%	33.6%	2.2%	1.9%	0.0%	5.6%	7.1%	39.6%	0.7%
Total male		121	45%								
Total female		147	55%								
Total overall		268									

Table 14—Demographic information—Great Glasshouse

This information was used to extrapolate the total sample size (discussed elsewhere) and to establish a baseline demography. It shows clearly the fundamental

differences between the users of the two venues. The visitors to the Glasshouse are predominantly in the '50 to 69' age group whereas the users in the Insight Gallery are younger, centred around the '18 to 20' age bracket. However, in the case of the latter, the distribution is much flatter, smeared across all the age groups from 'Up to 10' through to '50 to 69'.

At both venues the sex ratio of visitors is fairly evenly split.

6.5   Web statistics

The Google Analytics information provides some fascinating insights as well.

First the headline figures: In the pilot period 14th of August to the 8th of September the Insight Gallery in the National Museum had 95 visits from 83 unique users and 165 page views stemming 226 QR code scans.

In the period 19th of August to the 8th of September the Great Glasshouse at the National Botanic Garden had 295 visits from 228 unique users and 1,072 page views stemming from 1152 QR code scans.

If we take the calculated over all footfall estimated earlier along with the unique user counts we have a take up of 0.9% (in the Museum) and 2.4% (in the Gardens).

38% of Museum users and 54% of Gardens users penetrated further than the initial page they scanned so it would appear that the layering of information and allowing users to drill down was effective.

7% of the page views at the Museum and 1% at the Botanic Gardens were in Welsh. No survey information was submitted in Welsh. This might be considered as relatively low. However, most code scans led to an English page. If the user didn't change language, subsequent scans would still serve up English information. In addition, most overseas visitors would probably, when faced with a choice between English and Welsh, opt for the English version.

There are many more web metrics which readers may wish to examine, but these are perhaps the most significant, showing the major features of the system (bilingual information, layered information and obviously the scanning of QR codes to link into relevant information).

Chapter 7—Future directions

A number of directions for future investigation have already been suggested throughout the text. However, the researcher has also identified a number of so called "beneficial side effects" that could be realised with minimal effort using such a system and which merit an in-depth exploration of their efficacy.

The obvious first step, mentioned already, is the integration of the system into a venue's existing web and database systems. If this is achieved, then, through the careful application of appropriate tagging and a well-designed taxonomy, the same core materials can be used to catering for many different audiences—by age, by first language, by educational need—with different requirements (sometimes mutually exclusive). Obviously this could be implemented on a regular web site (and is to a certain extent on many bilingual sites for instance—serving up the same images to different language pages) but by using this system the information could be delivered right to the "coal face".

Other untapped opportunities include multi language audio tours and audio description for the partially sighted / blind to name but two.

From a pedagogic point of view, hard core educators will probably be asking "Where's the reflection?", "Where's the learning community?" and "Where's the interaction?" Obviously all those are missing from the current system (although users can download some files for later study and it is possible to bookmark pages in most browsers). However, mobile web browsing is inherently a bi-directional channel. To date the system has only been used to pull down data, but there is no reason why interaction data can't be sent back. So (theoretically) these facilities can be added relatively easily. However, interaction in this fashion is not trivial, especially if such items as images, audio recordings and video recordings are to be exchanged. The problem is even more acute if the ambition is to achieve all of these options—taking picture, recording notes, taking videos, and sharing them—without leaving the web browser. In practice there are many practical obstacles to overcome (moderation, identifying and joining the relevant group when there may be many

people involved and so on) but the author feels there is an enormous opportunity to add value in this fashion[111].

A related[112] avenue for investigation would be the integration of the QR code scanner in to the browser giving the user the facility to repeatedly scan codes without "app flipping" Again, it's not trivial and it also depends upon the widespread adoption of some of the newer browser standards, but it's certainly an ambition worth perusing.

The enthusiasm for this system is, however, not limited to just the researcher. The pilot venues both wanted the experiment to continue post pilot, at least for the immediate future, partially as a facility for their users and partially to gain further hard user data. There are also a whole series of data streams that are being collected that haven't yet been investigated in any great detail. All this additional information could, at the very least, help with the justification of a new, in depth study into other aspects of the use of this technology in this environment.

It would also be of great interest (assuming that the venues give up holding onto their pilots any time soon) to repeat the pilot projects again next year to see if there is a measurable increase in uptake.

Finally we come to the question of new, original materials. It is inevitable that as more codes are deployed and more content is repurposed, more "glue" pages will be required. And there will be a (possibly significant) resource implication for the venues involved. If their multi-lingual (over and above bilingualism) ambitions are realised the costs involved would definitely be considerable. In recent times some organisations (such as the National Library of Finland) have successfully used crowd sourcing techniques to "translate" obscure digitised texts into modern Finish. (Digitalkoot, 2011). It occurs to the author that similar crowd sourcing techniques could be used to help in this translation effort.

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[111] Part of the attraction of these ideas is that they can be achieved incrementally.
[112] Related in that the ambition is to realise it from within the web browser.

Chapter 8—Conclusions

In this project the author has investigated the ease with which a web based educational resource for delivery on mobile platforms, triggered by location specific QR codes could be developed and then utilised using repurposed content. The educational resource has been developed with relative ease[113] as intended, the supplied content repurposed and it has been piloted in two venues. The majority of the delivered materials were not original and arguably the "How easy" and the "content provided by a third party" aspects of the research have been successful.

The second aspect, about how users interact and perceived benefits is on the one hand clear cut. Overwhelmingly, the users who interacted with the system perceived a personal benefit. However, it could be said that an innovation that had a take up rate of between 0.9% and 2.4% of the potential audience is not particularly successful. Take up rates can be increased relatively easily and there are many things that can be done immediately (and cheaply) to increase the number of scan (as outlined earlier) including:

- bigger codes
- Calls to action ("**Scan me!**")
- Awareness raising (signs in the foyer, information on the web site, clearer signs at the gallery entrances)

The (well-advertised) presence of a wireless network also appears to be a significant factor in user adoption.

So does the take up of such a resource justify the cost/time/effort involved? In the end it boils down to a faith that QR code scanning (or at the very least similar location based services) will increase (built upon the knowledge that there is a perceived and ever louder "buzz" about QR codes and this type of activity). The author is firmly of the belief that it will. QR codes save precious space, are adaptable (the underlying information can easily be changed or added to on the fly) and they allow a richer layered experience. The case for their continued use appears to compelling.

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[113] Any difficulties and delays that may have occurred were more a factor of the researchers lack of experience with the chosen tools as opposed to inherent complexity.

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Appendices

Appendix 1—'Exit' Survey Questions[114]

All questions are optional. If you feel uncomfortable with providing the information then just skip the question, but please answer as many as you can (you need to answer at least one to be entered into the prize draw).

These questions are designed to provide information for an MSc. dissertation. All responses will be anonymised before the (venue name) sees them so please be as frank as you like.

It should take less than five minutes to complete.

There are 18 questions in this survey.

Hardware and Software

1 [1-01] Did you have a QR code scanner installed on your phone before visiting the (venue) and scanning the QR codes?

Please choose **only one** of the following[115]:
[Yes] [No]

2 [1-02] Had you ever scanned QR codes on your phone before?

Only answer this question if the following conditions are met[116]:
Answer was Y 'Yes' at question '1 [1-01]' (Did you have a QR code scanner installed on your phone before visiting the (venue) and scanning the QR codes?)

Please choose **only one** of the following:
[Yes] [No]

3 [1-03] Which mobile network do you use?

Please choose **only one** of the following:
[3] [O2] [Orange] [T-Mobile] [Vodafone] [Abica] [ASDA] [BT Mobile] [C Mobile] [Family

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[114] This is taken from the printable version that Lime survey allows users to export.
[115] When using the on-line version the "**only one**" functionality is handled automatically.
[116] When using the on-line version the "**…if the following conditions are met**" functionality is handled automatically.

Mobile] [giffgaff] [Kcom mobile] [LycaMobile] [Lebra Mobile] [Sainsbury] [Talkmobile] [TalkTalk] [Telecom plus] [Tesco] [Tru] [UK01] [Virgin] [Other][117]

If you're using data roaming please choose the network your phone has connected to.

4 [1-04] Did you use the wireless network at the venue or your mobile operators data network to receive the information?[118]

Please choose **only one** of the following:
[Wireless Network] [Mobile operators data network] [Both] [Don't Know]

5 [1-05] Were you using a 3G data connection?

Please choose **only one** of the following:
[Yes] [No] [Don't know]

6 [1-06] Is the phone you used to scan codes your usual phone or did you borrow it (from a parent or friend for instance) to take part in the experiment?

Please choose **only one** of the following:
[Usual phone] [Borrowed]

The Experience

7 [2-07] On a scale of 1 to 5—relating to your experience overall—did you find the time to view information reasonable?

Please choose **only one** of the following:
[I gave up—totally unusable] [I had to wait too long for most of the information, but I persisted] [I waited for most of the information, but it was Ok] [I wasn't particularly aware of the wait] [Fast and totally reasonable]

8 [2-08] On a scale of 1 to 5—relating to your experience overall and your information expectations/wants—did you find the information you viewed relevant to the artefacts you were viewing at the time?

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[117] These options were in a drop list with the top five UK providers at the top and the lesser operators in alphabetical order after that.
[118] This question was excluded from the National Museum Wales survey (at the time of the pilot project the public were not permitted to access their wireless network).

Please choose **only one** of the following:

[Totally irrelevant] [Partially relevant] [Neither totally relevant nor totally irrelevant] [Mostly relevant] [Totally relevant]

9 [2-09] On a scale of 1 to 5—relating to your experience overall—would you say that the use of QR codes enhanced your experience in the Insight Gallery

Please choose **only one** of the following:

[Detracted from my experience] [I got something out of it, but not much] [Neither enhanced nor detracted] [It was good, but could be better] [Enhanced my experience a great deal]

10 [2-10] Did you download anything—PDFs, PowerPoints, or movies for instance— for later review?

Please choose **only one** of the following:

[Yes] [No] [Didn't know I could]

11 [2-11] Did you book mark any page for later review?

Please choose **only one** of the following:

[Yes] [No] [Didn't know I could]

12 [2-12] Would you use QR codes again in a similar situation?

Please choose **only one** of the following:

[Yes] [No]

About You

13 [3-13] Please tell us your age group

Please choose **only one** of the following:

[Up to 10] [11 to 17] [18 to 29] [30 to 49] [50 to 69] [70 plus]

14 [3-14] Gender

Please choose **only one** of the following:

[Female] [Male]

15 [3-15] Please tell us where you live

Please choose **only one** of the following:

[South Wales] [UK] [Europe] [USA] [Asia] [Australasia] [Other]

16 [3-16] Is there anything you'd like to add? Suggestions? Comments?

Please write your answer here:

17 [3-17] Survey Language[119]

(No longer required as start language is recorded in data set.)

Alternative Uses

RMG have kindly underwritten some of the expenses associated with this study. They have requested that information be gathered on other uses of QR codes. As with the rest of the survey, these questions are optional, but please do enter your responses in the boxes below.

RMG will NOT have access to your personal information, only to the anonymised results.

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[119] This question was set to never appear as the survey language was one of the pieces of information automatically recorded by Lime Survey.

18 [4-18] How likely would you be to scan a QR code for the following reasons? 1 being very unlikely, 5 being likely

Please choose the appropriate response for each item:

	Very unlikely	Doubtful	Neither likely nor unlikely	Probably	Very likely
For access to audio or video files e.g. movie or album promo	[ ]	[ ]	[ ]	[ ]	[ ]
To access discount vouchers or coupons	[ ]	[ ]	[ ]	[ ]	[ ]
For direct access to a website (without the need to key in an address)	[ ]	[ ]	[ ]	[ ]	[ ]
To share information virally through social networks e.g. Facebook or Twitte	[ ]	[ ]	[ ]	[ ]	[ ]
To purchase tickets, goods or services through your smartphone	[ ]	[ ]	[ ]	[ ]	[ ]
To access travel information	[ ]	[ ]	[ ]	[ ]	[ ]
To access tourism information	[ ]	[ ]	[ ]	[ ]	[ ]
To take part in a survey e.g. restaurant feedback	[ ]	[ ]	[ ]	[ ]	[ ]
To review a product or service	[ ]	[ ]	[ ]	[ ]	[ ]

Thank you for filling in the survey.

If you opt to enter the prize draw then "Pob Luc" as we say in Wales.

Prize Draw[120]

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[120] This text was a link that launched a preformatted email sent to a specially created email address. This method of entering the prize draw ensured the separation of the entrants from their data, thus ensuring that there were no Data Protection issues regarding the storage of identifiable personal data.

Appendix 2—'Exit' Survey—Raw data

(See the CD for raw data spread sheets)

Comments—NBGW

3	More QR codes around the glasshouse for interesting/popular plants.
7	No thank you
14	Would be better if u had to find the qr codes rather than clicking the links once you've found one qr code! Good idea though! Would lie it if it had pictures I could use as a wallpaper?!
15	Having wifi to download an app about the attraction on arrival would be favourable as it is less battery intensive than scanning qr codes.
17	I have see the code on previous visits but decided not to use it as i thought it would be fiddly. i was surprised at how easy it was to use. It would be great to see it extended to the whole of the gardens. As a non gardener i dont know much about what i am seeing at the gardens so it would really be of help to me. i learnt a lot from just using it in the glass house. i would use it again as i come to the gardens at least twice a week for a few hours.
21	Being made more aware on entry of the QR codes and what info they would provide to enhance the visit
22	I wasn't aware there was a wireless connection or I would have used that as it was slow. However, I think this is an excellent idea and one that I think I will investigate in other scenarios.
24	This system has good potential. Very impressed. I have seen nothing like this in Canada except in print media like newspapers and magazines.
25	Been meaning to get the scanner app but never gor round to it till today! Was deffo worth it.
28	Great info on scans please remember disabled people can't always bend low so would require assistance at some points. I had a carer so was lucky. Good work
29	No

Comments—NMC

3	When traveling in Japan I noticed the use of QR codes everywhere. I couldn't make much use of them as I don't speak the language, so I'm happy to see them here.
4	The scan squares looked a little out of place when stuck on the side of cabinets. Could be positioned slightly better. My fiancé and I explained to another couple what the squares were. Maybe an explanation before entering the gallery.
7	Provide free wifi so that the online experience works
13	I wasn't able to use my mobile phone network to read the QR codes. The signal was too patchy and I had no 3G at all in the gallery. However, I did manage to join the museum's free public wifi network. I think the free wifi should have been publicised as part of the project (if it wasn't already?). Also, I'm a bit disappointed I missed the deadline for the prize draw. I tried to scan the QR codes a while ago but failed due to the patchy network signal. I only thought of the wifi today! Nice idea for a project tho. Perhaps worth developing more multimedia e.g. mp3 / video clips to accompany information on the webpages?

Appendix 3—'Welcome' Survey

Before you start on the rest of the (venue) I'd like it if you could answer three questions to set the research ball rolling:

How old are you? (mandatory[121])

I'd really like to know.

[Up to 10] [11 to 17] [18 to 29] [30 to 49] [50 to 69] [70 plus]

Male or female?

This one's optional but I'd still really like to know.

[Male] [Female]

Where do you live? (mandatory)

I'd also like to know just how far you've come to see us.

[South Wales] [UK] [Europe] [USA] [Asia] [Australasia] [Other]

Email[122]

The (venue) would like to e-mail you information one in a while. If you want to get these emails please put your address here. If you don't want the emails then simply leave it blank. Your email address will never be passed onto third parties.

[ ]

Language (Hidden)[123]

[English] [Welsh]

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[121] Some questions were set as "Mandatory" on the grounds that the researcher would rather have the users abandon the form altogether than submit it empty of data.

[122] This question was excluded from the National Museum Wales survey.

[123] The language field was set according to the language the participant undertook the survey in and hidden from view.

Appendix 4—'Welcome' Survey—Raw data

Botanic Garden

Welcome to the Great Glasshouse QR Code experiment						
Submission Details						
Serial	SID	Time	How old are you?	Male or female?	Where do you live?	Language
1	2	08/19/2011 - 12:01	18 to 29	Male	South Wales	English
2	3	08/19/2011 - 12:35	30 to 49	Male	UK	English
3	4	08/19/2011 - 16:08	30 to 49	Female	South Wales	English
4	5	08/20/2011 - 12:20	30 to 49	Male	South Wales	English
5	6	08/20/2011 - 12:59	30 to 49	Female	UK	English
6	7	08/21/2011 - 12:15	50 to 69	Female	South Wales	English
7	8	08/21/2011 - 13:46	30 to 49	Female	South Wales	English
8	9	08/21/2011 - 14:34	18 to 29	Male	UK	English
9	10	08/21/2011 - 14:35	30 to 49	Male	South Wales	English
10	11	08/21/2011 - 14:54	50 to 69	Female	UK	English
11	12	08/22/2011 - 13:16	30 to 49	Female	South Wales	English
12	13	08/27/2011 - 13:35	30 to 49	Male	UK	English
13	14	08/27/2011 - 13:40	30 to 49	Male	UK	English
14	15	08/27/2011 - 13:40	30 to 49	Male	UK	English
15	16	08/27/2011 - 14:51	30 to 49	Male	South Wales	English
16	17	08/28/2011 - 11:10	18 to 29	Male	South Wales	English
17	18	08/28/2011 - 13:17	Up to 10	Male	South Wales	English
18	19	08/28/2011 - 14:26	50 to 69	Female	UK	English
19	20	08/29/2011 - 13:11	30 to 49	Male	South Wales	English
20	21	08/29/2011 - 15:57	30 to 49	Male	South Wales	English
21	22	08/29/2011 - 16:47	30 to 49	Male	South Wales	English
22	23	08/30/2011 - 12:30	30 to 49	Male	UK	English
23	24	08/30/2011 - 13:05	18 to 29	Female	South Wales	English
24	25	08/30/2011 - 13:05	30 to 49	Female	South Wales	English
25	26	08/30/2011 - 14:07	18 to 29	Female	South Wales	English
26	27	08/31/2011 - 11:30	18 to 29	Male	South Wales	English
27	28	08/31/2011 - 12:23	30 to 49	Female	South Wales	English
28	29	08/31/2011 - 12:23	30 to 49	Female	South Wales	English
29	30	08/31/2011 - 12:32	70 plus	Male	UK	English
30	31	08/31/2011 - 13:06	18 to 29	Female	UK	English
31	32	08/31/2011 - 13:08	18 to 29	Male	UK	English
32	33	09/02/2011 - 13:19	18 to 29	Female	UK	English
33	34	09/02/2011 - 14:05	Up to 10	Male	South Wales	English
34	35	09/03/2011 - 10:15	50 to 69	Male	South Wales	English
35	36	09/03/2011 - 11:17	30 to 49	Female	UK	English
36	37	09/03/2011 - 15:10	50 to 69	Male	UK	English
37	38	09/03/2011 - 15:10	50 to 69	Male	UK	English
38	39	09/03/2011 - 15:10	50 to 69	Male	UK	English

39	40	09/03/2011 - 15:22	30 to 49	Male	South Wales	English
40	41	09/07/2011 - 12:53	18 to 29	Female	South Wales	English
41	42	09/07/2011 - 14:55	18 to 29	Male	UK	English
42	43	09/07/2011 - 15:14	50 to 69	Male	UK	English
43	44	09/08/2011 - 12:07	50 to 69	Male	South Wales	English
44	45	09/08/2011 - 13:11	30 to 49	Female	UK	English

National Museum

Welcome to the Insight QR Code experiment						
Submission Details						
Serial	SID	Time	How old are you?	Male or female?	Where are you from?	Language
1	3	08/13/2011 - 12:55	18 to 29	Male	Europe	English
2	4	08/16/2011 - 13:06	18 to 29	Male	USA	English
3	5	08/19/2011 - 11:43	30 to 49	Female	South Wales	English
4	6	08/27/2011 - 11:16	30 to 49	Female	South Wales	English
5	7	08/28/2011 - 11:25	11 to 17	Male	UK	English
6	8	09/01/2011 - 13:48	18 to 29	Male	South Wales	English
7	9	09/02/2011 - 11:02	30 to 49	Male	South Wales	English
8	10	09/02/2011 - 11:35	11 to 17	Male	UK	English
9	11	09/02/2011 - 15:57	18 to 29	Male	South Wales	English
10	12	09/04/2011 - 15:00	18 to 29	Female	South Wales	English
11	13	09/06/2011 - 13:59	18 to 29	Male	UK	English
12	14	09/06/2011 - 13:59	18 to 29	Male	Asia	English

Appendix 5—'Did not scan' poll questions

The flowchart question methodology (Figure 11) was realised in the form of the following questions and polling procedure:

The venue visitor was shown a QR code and asked if they had scanned any on their visit. If the answer was no then the following questions were asked:

Why didn't you scan code? Please identify the statement that most accurately describes the reason you *didn't* scan a QR code today:

1. I didn't see codes.
2. I saw them but didn't know what they were.
3. I saw them, knew what they were, but didn't have a phone (*supplemental question*—at all or just not with you?)
4. I saw them, knew what they were, but my phone can't scan (*supplemental question*—What is the make and model of your phone?)
5. I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed (*supplemental question*—Would you install one if it were fast and free?)
6. I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/signal (*supplemental question*—Would you if there was a data connection/signal or wireless network?)
7. I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan.

Additional information gathered:

- Sex (by observation)
- Age (Please tell me which age bracket you fall into
  [Up to 10] [11 to 17] [18 to 29] [30 to 49] [50 to 69] [70 plus] or by observation)

Appendix 6—'Did not scan'—Raw data

National Botanic Garden

Date	06-Sep-11							
Location	National Botanic Garden Wales							
I didn't see codes	I saw them but didn't know what they were	I saw them, knew what they were, but didn't have a phone	I saw them, knew what they were, but my phone can't scan	I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/ signal	I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan	M/F	Age
	1						M	50 to 69
	1						F	50 to 69
	1						F	50 to 69
				1			F	30 to 49
	1						M	30 to 49
	1						F	up to 10
				1			M	18 to 29
				1			F	18 to 29
				1			M	50 to 69
				1			F	50 to 69
	1						M	50 to 69
	1						F	50 to 69
	1						M	70 plus
		1					F	50 to 69
			1				M	18 to 29
			1				F	18 to 29
			1				M	50 to 69
	1						F	50 to 69
	1						F	30 to 49
		1					M	50 to 69
	1						M	50 to 69
	1						M	50 to 69
	1						M	50 to 69
	1						F	30 to 49

								Sex	Age
			1					M	50 to 69
			1					F	50 to 69
		1						M	50 to 69
		1						F	50 to 69
				1				F	30 to 49
				1				F	30 to 49
		1						M	50 to 69
		1						F	50 to 69
				1				M	50 to 69
				1				F	50 to 69
		1						M	50 to 69
		1						F	50 to 69
		1						F	50 to 69
		1						F	50 to 69
			1					M	50 to 69
				1				F	50 to 69
		1						M	30 to 49
		1						F	50 to 69
		1						F	18 to 29
				1				M	50 to 69
				1				F	50 to 69
				1				F	30 to 49
				1				F	50 to 69
				1				F	50 to 69
				1				F	50 to 69
		1						M	50 to 69
				1				M	50 to 69
				1				M	50 to 69
				1				F	50 to 69
				1				F	50 to 69
				1				F	50 to 69
		1						F	50 to 69
		1						F	50 to 69
		1						M	50 to 69
				1				F	18 to 29
				1				F	50 to 69
				1				M	30 to 49
		1						F	30 to 49
		1						F	up to 10
		1						F	50 to 69
		1						F	50 to 69
		1						F	50 to 69
			1					F	50 to 69
				1				M	50 to 69
				1				F	50 to 69
					1			M	50 to 69

					Sex	Age
		1			M	50 to 69
			1		M	30 to 49
			1		F	30 to 49
	1				F	up to 10
	1				M	70 plus
	1				F	70 plus
	1				F	50 to 69
1					F	50 to 69
	1				M	50 to 69
	1				F	50 to 69
	1				M	70 plus
	1				M	50 to 69
	1				F	50 to 69
	1				F	50 to 69
	1				M	70 plus
	1				M	50 to 69
	1				F	50 to 69
	1				M	50 to 69
	1				F	50 to 69
			1		M	50 to 69
			1		F	50 to 69
	1				F	50 to 69
	1				M	70 plus
	1				F	50 to 69
	1				M	50 to 69
	1				F	50 to 69
			1		M	50 to 69
			1		F	50 to 69
	1				F	50 to 69
	1				M	50 to 69
	1				M	30 to 49
				1	F	30 to 49
	1				F	50 to 69
		1			M	50 to 69
1					F	30 to 49
	1				F	30 to 49
	1				F	50 to 69
	1				M	50 to 69
1					F	30 to 49
1					F	50 to 69
	1				F	50 to 69
	1				M	50 to 69
		1			F	50 to 69
1					M	50 to 69
	1				F	50 to 69
	1				F	50 to 69

			1					M	50 to 69
			1					M	30 to 49
			1					M	50 to 69
			1					F	30 to 49
			1					F	50 to 69
		1						M	50 to 69
		1						F	50 to 69
		1						F	50 to 69
		1						M	50 to 69
			1					M	30 to 49
			1					F	18 to 29
			1					M	50 to 69
		1						F	50 to 69
		1						F	50 to 69
		1						M	50 to 69
5	72	17	30	7	0	0			
Count	131								
M	54								
F	77								
	131								
up to 10	3								
11 to 17	0								
18 to 29	7								
30 to 49	20								
50 to 69	95								
70 plus	6								
	131								

Table 15—"Did not scan" raw data—Botanic Garden

National Museum

Date	07-Sep-11							
Location	National Museum Cardiff							
I didn't see codes	I saw them but didn't know what they were	I saw them, knew what they were, but didn't have a phone	I saw them, knew what they were, but my phone can't scan	I saw them, knew what they were, my phone can scan, but I haven't got a scanner installed	I saw them, knew what they were, my phone can scan, I have got a scanner installed, but I have no connection/signal	I saw them, knew what they were, my phone can scan, I have got a scanner installed, I have a connection/signal, but I have no wish to scan	M/F	Age
1							F	30 to 49
1							F	50 to 69
1							M	18 to 29
1							M	11 to 17
				1			M	11 to 17
1							F	18 to 29
1							F	50 to 69
				1			M	18 to 29
			1				F	11 to 17
1							M	18 to 29
			1				M	18 to 29
			1				F	18 to 29
			1				F	30 to 49
			1				F	50 to 69
				1			M	18 to 29
				1			F	18 to 29
1							F	18 to 29
1							M	18 to 29
						1	F	30 to 49
			1				F	18 to 29
			1				F	18 to 29
			1				F	18 to 29
			1				M	18 to 29
1							F	18 to 29
1							F	18 to 29
1							F	50 to 69

							M/F	Age
	1						M	18 to 29
1							M	18 to 29
	1						F	50 to 69
			1				M	18 to 29
1							M	30 to 49
	1						M	11 to 17
					1		M	11 to 17
			1				F	30 to 49
1							M	50 to 69
1							F	50 to 69
1							F	18 to 29
		1					M	30 to 49
		1					M	18 to 29
		1					F	18 to 29
1							M	18 to 29
1							F	18 to 29
1							M	50 to 69
1							M	18 to 29
1							F	18 to 29
1							M	18 to 29
1							M	18 to 29
1							M	18 to 29
1							F	18 to 29
1							F	18 to 29
1							F	18 to 29
	1						F	18 to 29
			1				M	18 to 29
1							M	30 to 49
1							M	30 to 49
			1				M	30 to 49
			1				F	18 to 29
1							F	18 to 29
				1			F	11 to 17
				1			F	11 to 17
					1		F	18 to 29
1							M	11 to 17
1							F	18 to 29
1							M	18 to 29
1							F	18 to 29
1							M	50 to 69
1							F	50 to 69
1							M	18 to 29
1							F	50 to 69
1							M	30 to 49
1							M	11 to 17
1							M	11 to 17

								Gender	Age
				1				M	18 to 29
	1							F	18 to 29
1								F	18 to 29
						1		M	18 to 29
1								F	18 to 29
1								F	30 to 49
	1							F	30 to 49
			1					F	30 to 49
	1							M	30 to 49
	1							F	30 to 49
	1							M	11 to 17
	1							F	11 to 17
	1							F	11 to 17
1								M	50 to 69
1								F	50 to 69
	1							M	18 to 29
					1			F	18 to 29
1								M	50 to 69
1								F	50 to 69
1								F	18 to 29
1								F	11 to 17
			1					M	11 to 17
1								M	30 to 49
1								F	30 to 49
1								M	18 to 29
1								M	50 to 69
1								F	50 to 69
1								M	18 to 29
	1							M	11 to 17
	1							F	11 to 17
			1					M	11 to 17
1								F	50 to 69
			1					M	50 to 69
	1							F	11 to 17
	1							F	11 to 17
	1							M	11 to 17
			1					M	50 to 69
1								F	30 to 49
1								M	11 to 17
1								F	11 to 17
1								M	30 to 49
		1						F	18 to 29
	1							F	30 to 49
1								F	30 to 49
							1	F	30 to 49
			1					F	11 to 17

			1				F	11 to 17
			1				F	11 to 17
						1	F	11 to 17
1							F	30 to 49
1							F	30 to 49
	1						M	30 to 49
				1			M	30 to 49
1							M	30 to 49
1							F	18 to 29
1							M	11 to 17
1							M	11 to 17
	1						F	50 to 69
1							M	50 to 69
1							M	11 to 17
					1		F	11 to 17
					1		F	18 to 29
	1						F	30 to 49
		1					F	30 to 49
					1		M	11 to 17
	1						F	11 to 17
1							F	30 to 49
	1						F	18 to 29
		1					M	18 to 29
	1						F	11 to 17
1							F	30 to 49
			1				M	18 to 29
			1				F	11 to 17
			1				F	11 to 17
1							M	50 to 69
1							M	50 to 69
1							M	11 to 17
1							M	11 to 17
77	24	6	25	9	6	3		
Count	150							
M	68							
F	82							
	150							
up to 10	0							
11 to 17	38							
18 to 29	57							
30 to 49	31							
50 to 69	24							
70 plus	0							

	150							

Table 16—"Did not scan" raw data—National Museum

Appendix 7—Site Policies

Disclaimer

This web site is designed, maintained and hosted by Paul Stokes for the purposes of undertaking research into the use of QR codes.

Privacy Policy

All personal data is collected and processed in compliance with the Data Protection Act 1998 and will not be transferred to any third parties.

Survey

- This survey is being carried out by Paul Stokes, a research student at the University of Glamorgan. The information provided will form part of a student's MSc project.
- All information provided as part of the survey is anonymous.
- No information is gathered that allows the identity of a living person to be ascertained.
- The aim of the research is to answer the following questions:
    - How easy (or difficult) it is to develop a web based educational resource for delivery on mobile platforms, triggered by location specific QR codes, using as far as possible existing content provided by a third party?
    - Does the take up of such a resource justify the cost and effort involved?
    - How do users interact with such a resource?
    - Could such a resource have an impact upon learning outcomes?
- Aggregated results of the survey will be published in an MSc dissertation and a project overview. This dissertation and project overview may be shared with third parties including, but not limited to, the University of Glamorgan, The National Botanic Garden of Wales, and RMG limited. No personal data will be presented in these final reports.

Prize draw

- Email addresses will be solicited as entries for a prize draw such that no address can be linked back to any individual's survey responses.
- Entry into the prize draw is optional.
- The emails will only be used to contact the eventual winner and will not be passed onto any third party.
- The email addresses will be kept until the prize has been successfully won or until the 30th of September 2011, whichever is earlier.

- People entering the prize draw will be required to confirm that they are over the age of 16 or that they have obtained parental consent to enter. Users without consent will not be eligible for the prize draw and are not allowed to provide me with personal information.

(See prize draw terms and conditions for additional information)

Cookies

- The websites used to enact this study use session cookies to maintain interface choices (such as text size) across different web pages. These expire at the end of the session.
- The survey web site uses a cookie to ensure that users only enter data once. This expires after 365 days

Prize Draw Terms and Conditions

I like to keep things simple so here goes:

1. There's only one prize, "From Another Kingdom", and there are no alternatives.
2. One entry per person.
3. The prize will be awarded at random to one of the people who submit at least one answer to the survey and enter their email address in the appropriate box before the closing date.
4. We'll send it wherever and to whoever you choose (the winner will be contacted by email).

The prize draw closes on the 5th of September (midnight UK BST). Any surveys submissions received after then will be welcomed for research purposes, but won't be entered in the draw. The winner will be contacted sometime in September.

Prize draw entry link

Thank you for completing the survey and opting to enter the competition.

Please click the link below to send me your details. It will open a pre-addressed email in your local email client that you can use to send me your details. This will be sent to and stored for the duration of the prize draw on a different server. This method of sending me your information ensures the separation between any survey information you may have entered and any personal information in your email and safeguards your privacy.

The email contains a confirmation that you are either aged 16 or over or that you parental consent to send the email.

Email messages without this confirmation will be deleted and not entered into the prize draw.

Click here to enter

Prize draw email format

Mailto:

Subject: NBGW Prize Draw Entry

Body: Please enter me in the prize draw.
I confirm that I am either aged 16 or over or that I have parental consent to send this email.

Appendix 8—QR Code Installation records

National Botanic Garden

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
Ecology						
1 - Cape reeds	http://nbgw.whatsthis.mobi/en/category/national-botanic-garden-wales/ecology/1-cape-reeds	goo.gl/yG4lf		1-cape-reeds.png	goo.gl/FuLqQ	
2 - Erica caffra	http://nbgw.whatsthis.mobi/en/content/2-erica-caffra	goo.gl/gxut3		2-erica-caffra.png	goo.gl/HYgV8	
3 - Mountain Laurel forests	http://nbgw.whatsthis.mobi/en/content/3-mountain-laurel-forests	goo.gl/WMQeW		3-mountain-laurel.png	goo.gl/lyfdg	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
4 - Chaparral	http://nbgw.whatsthis.mobi/en/content/4-chaparral	goo.gl/aQMhM		4-chaparral.png	goo.gl/838kN	
5 - Grevillea maccutcheonii	http://nbgw.whatsthis.mobi/en/content/5-grevillea-maccutcheonii	goo.gl/ogCJx		5-grevillea.png	goo.gl/jkhD3	
6 - Hakeas and banksias	http://nbgw.whatsthis.mobi/en/content/6-hakeas-and-banksias	goo.gl/v9FMN		6-hakeas.png	goo.gl/s3oPd	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
7 - Puya	http://nbgw.whatsthis.mobi/en/content/7-puya	goo.gl/xkT5w		7-puya.png	goo.gl/rM8uX	
8 - Euphorbias and aeoniums	http://nbgw.whatsthis.mobi/en/content/8-euphorbias-and-aeoniums	goo.gl/yvB6Z		8-euphorbias.png	goo.gl/43ZZ2	
9 - Rosemary (and lavender, myrtle)	http://nbgw.whatsthis.mobi/en/content/9-rosemary-and-lavender-myrtle	goo.gl/o0oY9		9-rosemary.png	goo.gl/Zc3FH	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
10 - King protea	http://nbgw.whatsthis.mobi/en/content/10-king-protea	goo.gl/NYTTh		10-king-protea.png	goo.gl/NzBZa	
11 - Leucadendron	http://nbgw.whatsthis.mobi/en/content/11-leucadendron	goo.gl/OIRTg		11-leucadendron.png	goo.gl/LY9Hg	
12 - Watsonia	http://nbgw.whatsthis.mobi/en/content/12-watsonia	goo.gl/P0FUB		12-watsonia.png	goo.gl/BapxF	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
Sensory						
1 - Lavender	http://nbgw.whatsthis.mobi/en/content/1-lavender	goo.gl/YWydp		1-lavender.png	goo.gl/cexF4	
2 - Pelargonium papilionaceum	http://nbgw.whatsthis.mobi/en/content/2-pelargonium-papilionaceum	goo.gl/oKMOH		2-pelargonium.png	goo.gl/UPQrX	
3 - Boronia heterophylla	http://nbgw.whatsthis.mobi/en/content/3-boronia-heterophylla	goo.gl/2ZoP6		3-boronia.png	goo.gl/ac2uw	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
4 – Californian Sagebush	http://nbgw.whatsthis.mobi/en/content/4-californian-sagebrush	goo.gl/46EyQ		4-californian-sagebush.png	goo.gl/0Ae13	
5 - Ñipa tree	http://nbgw.whatsthis.mobi/en/content/5-%C3%B1ipa-tree	goo.gl/lxSXK		5-nipa-tree.png	goo.gl/FZV9X	
6 - Teline stenopetala	http://nbgw.whatsthis.mobi/en/content/6-teline-stenopetala	goo.gl/FX4bZ		6-teline.png	goo.gl/WESrR	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
Survival						
1 - White sage	http://nbgw.whatsthis.mobi/en/content/1-white-sage	goo.gl/HHqnN		1-white-sage.png	goo.gl/6fNGg	
2 - Sagebush	http://nbgw.whatsthis.mobi/en/content/2-sagebush	goo.gl/Ulkfn		2-sagebush.png	goo.gl/Rx8w4	
3 - Columbine	http://nbgw.whatsthis.mobi/en/content/3-columbine	goo.gl/P5Y69		3-columbine.png	goo.gl/XfYVn	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
4 - Grass tree	http://nbgw.whatsthis.mobi/en/content/4-grass-tree	goo.gl/lpJoZ		4-grass-tree.png	goo.gl/FXAAw	
5 - Wattle tree	http://nbgw.whatsthis.mobi/en/content/5-wattle-tree	goo.gl/hZDfg		5-wattle-tree.png	goo.gl/2n5CP	
Signs						
Welcome	http://nbgw.whatsthis.mobi/en/welcome/welcome	goo.gl/loYPz		welcome-eng.png	goo.gl/w7p1w	

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
Croeso	http://nbgw.whatsthis.mobi/cy/croeso/croeso	goo.gl/Ykmox		welcome-cy.png	goo.gl/EnxLa	
Exit	http://nbgw.whatsthis.mobi/en/exit/survey	goo.gl/J1XZm		englishexit.png	goo.gl/yGLc5	
Allan	http://nbgw.whatsthis.mobi/cy/allan/ymadael	goo.gl/CD7RY		welshexit.png	goo.gl/Q4qv2	

Table 17—QR code installation record—Botanic Garden

National Museum

Subject	URL	Google short code - QR	QR	QR File name	Google short code – no QR	Location visual
Banded Snail	http://nmc.whatsthis.mobi/en/content/find-out-more-how-identify-banded-snails	goo.gl/Tm87S		brandedsnail.png	goo.gl/rQ7D0	
Biological Taxonomy	http://nmc.whatsthis.mobi/en/content/read-more-about-science-taxonomy	goo.gl/F2CHn		taxonomy.png	goo.gl/HsfBd	
Bird Skins	http://nmc.whatsthis.mobi/en/content/click-here-more-images-bird-skins-museum-collections	goo.gl/VFDcB		birdskins.png	goo.gl/y9DXf	

Cave Spider	http://nmc.whatsthis.mobi/en/content/hidden-worlds-cave-spider-search-0	goo.gl/w0zTp		cavespider.png	goo.gl/PO2yy	
Collections Character	http://nmc.whatsthis.mobi/en/content/read-more-about-collections	goo.gl/JpA5M		collections.png	goo.gl/XBKIH	
Research Character	http://nmc.whatsthis.mobi/en/content/research-and-insight-gallery	goo.gl/QjeYf		research.png	goo.gl/wBwrU	

Seabed Life	http://nmc.whatsthis.mobi/en/content/seabed-life-our-doorstep	goo.gl/JSPV7		seabed.png	goo.gl/GCkEi	
Whitebeams	http://nmc.whatsthis.mobi/en/content/whitebeam	goo.gl/Sx2f5		whitebeams.png	goo.gl/YfTQH	
Fish Case	http://nmc.whatsthis.mobi/en/content/fish-case	goo.gl/cnxzE		fish.png	goo.gl/LQ69j	
Welcome	http://nmc.whatsthis.mobi/en/welcome/welcome	goo.gl/zEtzL		welcome-eng.png	goo.gl/rTH5z	

Croeso	http://nmc.whatsthis.mobi/cy/croeso/croeso	goo.gl/Q8BSf		welcome-cy.png	goo.gl/HMEGP	
Exit	http://nmc.whatsthis.mobi/en/exit/survey	goo.gl/HJkBR		englishexit.png	goo.gl/rBDk2	
Allan	http://nmc.whatsthis.mobi/cy/allan/ymadael	goo.gl/k44Cy		welshexit.png	goo.gl/PfLpC	

Table 18—QR code installation record—Museum

Appendix 9—Signs and Codes artwork

Appendix 9—Signs and Codes artwork

Croeso i'r Arbrawf Côd QR yma

Côd QR? Beth yw hwn?

Mae'n **Côd Ymateb Cyflym**. Edrychwch islaw. Dyna un. Os oes ganddoch chi ffôn smart gyda sganiwr QR wedi'i osod* yna mae adnoddau ychwanegol ar gael i chi i weld are eich ffôn wrth i chi gerdded o gwmpas Insight. Yn syml, sganiwch pob un côd yr ydych yn dod ar draws iddo ac arhoswch i weld beth sy'n dod i fyny. Mae yna gwybodaeth ychwanegol am y gwrthrychau a'r gweithgareddau tu ôl i'r llenni yn yr Amgueddfa. Edrychwch allan am y dolennau ar eich ffôn.

Mae Paul Stokes yn myfyriwr rhan-amser ym Mhrifysgol Morgannwg ac yn ceisio darganfod ychydig o wybodaeth am sut mae pobl yn defnyddio codau QR mewn llefydd fel yr Amgueddfa felly sganiwch y côd diwethaf ar eich ffordd allan a chwblhewch yr arolwg. Bydd pawb sy'n cwblhau'r arolwg gyda'r dewis i gael eu rhoi mewn i raffl. Y wobr? Bydd rhaid i chi sganio'r côd i ffeindio allan!

*Peidiwch â phoeni os nad oes ganddoch chi sganiwr QR wedi'i osod. Mae gan y rhan fwyaf o siopau App rhai am ddim ac mae gosodiad dros 3G ond yn cymryd ychydig o funudau. Rydym wedi rhoi dolen i sganiwr ar y gwaelod.

Welcome to this QR Code Experiment

QR Code? What's that?

It's a **Quick Response Code**. Look below. That's one. If you have a smart phone with a QR scanner installed* then there are additional resources available for you to see on your phone as you walk around Insight. Simply scan each code as you come across it and see what pops up. There's further information about the objects and the activities behind the scenes at the Museum. Just look for the links on your phone.

A research student at the University of Glamorgan, Paul Stokes is conducting this experiment, is trying to find out a little bit about how people use QR codes in places like the Museum so please scan the last code on your way out and complete the short survey it links to. Anyone who completes the survey has the option of entering a prize draw. The prize? You'll have to scan the code to find out!

* Don't worry if you don't have a scanner installed. Most App stores have several free ones and installation over 3G takes a matter of moments. We've put a link for a scanner at the bottom.

Sganiwch fi!

Scan me!

http://goo.gl/HMEGP

http://goo.gl/rTH5z

Cael eich darllenydd côd QR yma

Er mwyn is-lwytho darllenydd côd QR agorwch http://get.beetagg.com ar borwr we eich ffon. Bydd y rhan fwyaf o ffonau yn ei ganfod yn awtomatig a bydd dolen is-lwytho yn cael ei arddangos. Mae'r sganiwr Beetag yn cynorthwyo Android, iOS, Samsung Bada, Nokia Symbian (pob fersiwn), Windows Mobile 5.5+, Windows phone 7, J2me, Palm OS a Blackberry. Fel arall, ewch i siop App eich ffon – gweler http://goo.gl/CqqT2

Sylwer: Ni ellir defnyddio rhwydweithiau di-wifr yr Amgueddfa, gan gynnwys y rhwydwaith heb ei ddiogelu "Cyhoeddus", ar hyn o bryd. Anwybyddwch/ Canslwch unrhyw awgrymebau i fewngofnodi os gwelwch yn dda.

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Get your QR code reader here

To download a QR code reader open **http://get.beetagg.com** on your phones web browser. Most phones will be automatically detected and a download link displayed. The Beetag scanner supports Android, iOS, Samsung Bada, Nokia Symbian (all versions), Windows Mobile 5.5+, Windows Phone 7, J2me, Palm OS and BlackBerry. Alternatively, go to your phones app store—see http://goo.gl/CqqT2

Please Note: The Museums wireless networks, including the unsecured network "Public", are not currently usable. Please ignore/cancel any prompts to login in.

Diolch yn Fawr am gymryd rhan mewn Arbrawf Côd QR

Nawr mae'n amser i gymryd rhan yn ein raffl

Sganiwch yma am fanylion

Sganiwch fi!

Many Thanks for taking part in the QR Code Experiment

Now it's time to enter the prize draw

Scan here for details

Scan me!

http://goo.gl/PfLpC

http://goo.gl/rBDk2

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Welcome to the Great Glasshouse QR Code Experiment

QR Code?

What's that?

It's a **Quick Response Code**. Look to the right. That's one. If you have a smart phone with a QR scanner installed[*] then there are additional resources available for you to see on your phone as you walk around the Glasshouse. Simply scan each code as you come across it and see what pops up. There's additional information about the plants, pictures and maps showing where you are in the Glasshouse. There are even three guided trails around the Glasshouse; the Ecology Trail, the Sensory Trail and the Survival trail. Just look for the links on your phone.

There is a wireless network in the Glasshouse—(network label)—so you don't have to worry about your network coverage and data charges. When you try to open a web page most phones will detect it and ask if you want to join. Just say yes.

We're trying to find out a little bit about how people use QR codes in places like the Gardens so please scan the last code on your way out and let us have your email address. We'll send you a link to a (very) short survey. Anyone who completes the survey will be entered into a prize draw. The prize? You'll have to scan the code to find out!

[*] Don't worry if you don't have a scanner installed. Most App stores have several free ones and using the wireless network inside the Glasshouse means installation takes a matter of moments. We've put a link for a scanner on the right.

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Scan me!

http://goo.gl/67DY1

Get your QR code reader here

To download a QR code reader open **http://get.beetagg.com** on your phones web browser. Most phones will be automatically detected and a download link displayed. The Beetag scanner supports Android, iOS, Samsung Bada, Nokia Symbian (all versions), Windows Mobile 5.5+, Windows Phone 7, J2me, Palm OS and BlackBerry.

Alternatively, go to your phones app store—see (Web page link).

Croeso i Arbrawf Côd QR y Tŷ Gwydr Mawr

Côd QR?

Beth yw hwn?

Mae'n **Côd Ymateb Cyflym** ('Quick Response Code'). Edrychwch i'r dde. Dyna un. Os oes ganddoch chi ffôn smart gyda sganiwr QR wedi'i osod[*] yna mae adnoddau ychwanegol ar gael i chi i weld are eich ffôn wrth i chi gerdded o gwmpas y Tŷ Gwydr. Yn syml, sganiwch pob un côd yr ydych yn dod ar draws iddo ac arhoswch i weld beth sy'n dod i fyny. Mae yna gwybodaeth ychwanegol am y planhigion, lluniau a mapiau i ddangos ble rydych chi yn y Tŷ Gwydr. Mae yna hyd yn oed tri trywydd tywysedig o gwmpas y Tŷ Gwydr: y Drywydd Ecoleg, y Drywydd Synhwyraidd a'r Drywydd Goroesiad. Edrychwch allan am y dolennau ar eich ffôn.

Mae yna rhwydwaith di-wifr ar gael yn y Tŷ Gwydr—"ResQ at the Glasshouse"—felly does dim angen poeni am eich darllediadau rhwydwaith a thaliadau data. Pan fyddwch yn ceisio agor tudalen we mae'r rhan fwyaf o ffonau yn ei ganfod ac yn gofyn os hoffech ymuno. Dywedwch ie.

Rydym yn ceisio draganfod ychydig o wybodaeth am sut mae pobl yn defnyddio codau QR mewn llefydd fel y Gerddi felly sganiwch y côd diwethaf ar eich ffordd allan a gadewch i ni gael eich cyfeiriad e-bost os gwelwch yn dda. Byddwn yn anfon dolen i arolwg byr (iawn). Bydd pawb sy'n cwblhau'r arolwg yn cael eurhoi mewn i raffl. Y wobr? Bydd rhaid i chi sganio'r côd i ffeindio allan!

[*] Peidiwch â phoeni os nad oes ganddoch chi sganiwr QR wedi'i osod. Mae gan y rhan fwyaf o siopau App rhai am ddim ac mae defnyddio'r rhwydwaith di-wifr o fewn y Tŷ Gwydr yn golygu bod y gosodiad ond yn cymryd ychydig o funudau. Rydym wedi rhoi dolen i sganiwr ar y dde.

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Sganiwch fi!

http://goo.gl/EnxLa

Cael eich darllenydd côd QR yma

Er mwyn is-lwytho darllenydd côd QR agorwch **http://get.beetagg.com** ar borwr we eich ffon. Bydd y rhan fwyaf o ffonau yn ei ganfod yn awtomatig a bydd dolen is-lwytho yn cael ei arddangos. Mae'r sganiwr Beetag yn cynorthwyo Android, iOS, Samsung Bada, Nokia Symbian (pob fersiwn), Windows Mobile 5.5+, Windows phone 7, J2me, Palm OS a Blackberry.

Fel arall, ewch i siop App eich ffon—gweler http://goo.gl/yDAo5.

Appendix 10—Final QR code positions

National Museum Insight Gallery

Cave spider	
Collections character	
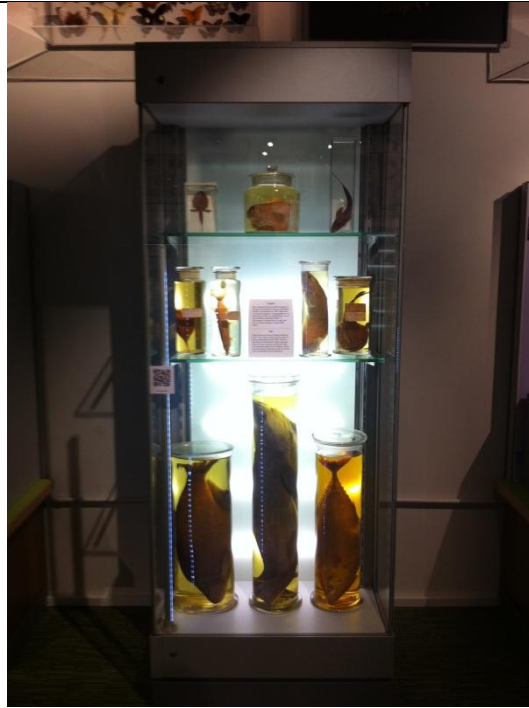
Fish case	
Research character	

Seabed life	
Whitebeams	
Biological Taxonomy (character)	
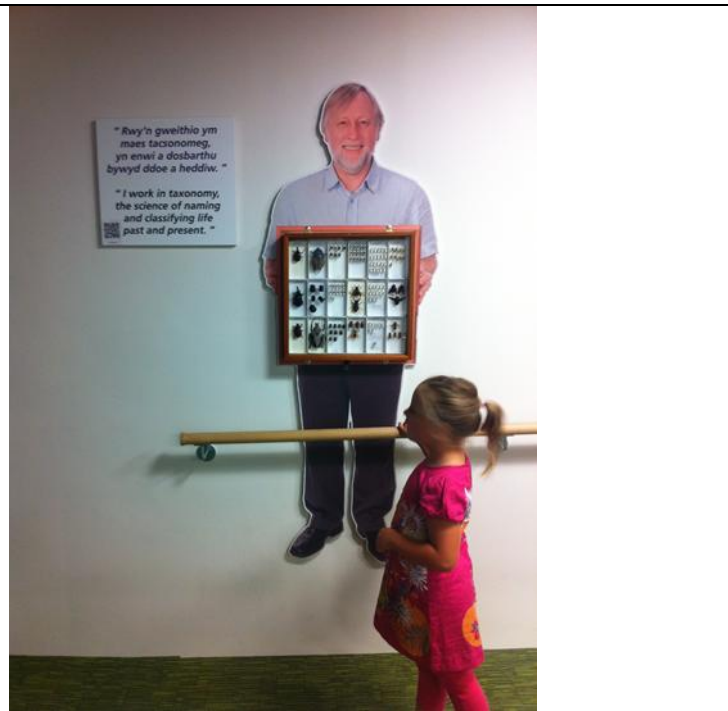
Banded Snail	
Bird skins case	

Table 19—Final QR code locations—Museum

National Botanic Garden Great Glasshouse

| White Sage | |
| Sagebush | |

| Grevillea maccutcheonii | |
| Californian Sagebush | |

Chaparral	
Columbine	
Mountain Laurel forests	

Erica caffra	
Cape reeds	

Boronia heterophylla	
Grass tree	

| Hakeas and banksias | |
| Wattle tree | |
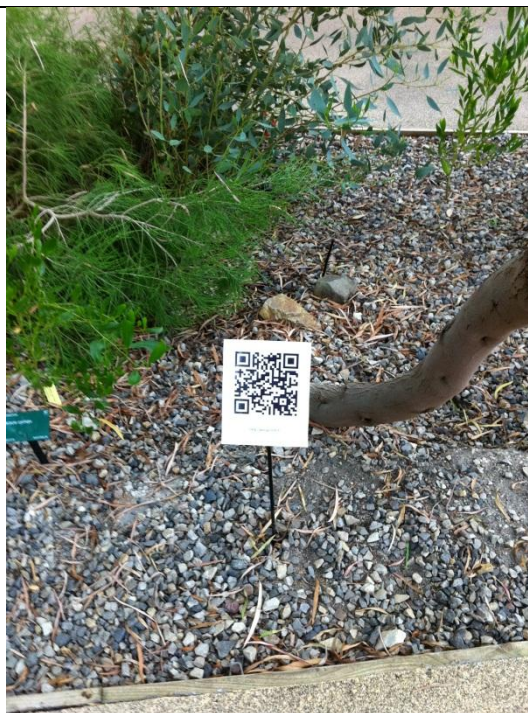
Puya	
Ñipa tree	

Euphorbias and aeoniums	
Teline stenopetala	

Lavender	
Rosemary (and lavender, myrtle)	

| King protea | |
| Pelargonium papilionaceum | |

Leucadendron	
Watsonia	

Table 20—Final QR code locations—Botanic Garden