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EPOCH

Excellence in Processing Open Cultural Heritage

Network of Excellence

Information Society Technologies

D.2.3.1: Report on Horizontal Integration

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Ename Center For Public Archaeology and Heritage Presentation

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Executive Summary

The objective of Horizontal Integration activity is to identify the technologies that could successfully be introduced in the CH domain.

The information about new technologies was gathered though different channels: a Permanent Market Watch, consisting of internet searches, reading technology watch reports and attending several conferences and exhibitions dealing with technology in general and CH in particular, and a Horizontal Integration Unit, bringing together interested network partners.

The results of this Work Package should be published on a website, to keep it dynamic with the constant input of new information and the reaction of the reader to the posted articles.

During the research, a number of technologies have been identified that can clearly be earmarked as potentially promising for CH. Most of them are centred on the personalisation of the CH experience.

An RFID or Radio Frequency Identification tag can be read from a distance, ranging from a few cm to many meters. The identification of an object or person paves the way to a whole spectrum of new applications and services, from asset tracking to dynamic presentation systems. Besides the application of the RFID technology itself, rules and standards for their use in the CH domain need to be defined.

Another interesting technology group are PAN, or Personal Area Networks, though communication protocols such as Bluetooth. Letting different devices communicate with each other over a short distance, typically 10 m, let selected users talk to each other, exchange information or collaborate in games or educational quizzes, without the interference of other museum visitors.

The final conclusion of this Work Package is that any forthcoming technological development will have to fit the needs of archaeologists, museums, sites and visitors. If not, the integration of new technologies will further alienate those users from the opportunities that are created by technology in the Cultural Heritage domain.
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1 Introduction

Integrating Activities, the second workpackage of EPOCH, undertakes activities to coordinate and integrate the work of partners and secures the correct inputs to the work of the Network. The goal of the EPOCH network is to formulate a research agenda to develop the proper IT tools that optimally benefit the Cultural Heritage community.

The definition of the needs of the stakeholders in the CH domain was the first task. WP 2.2, Vertical Integration, creates the inventory of IT technologies that are already used in the CH domain.

Activity 2.3, Horizontal Integration has one main objective: to identify the technologies that could successfully be applied in the Cultural Heritage Domain.

The results from this work package, together with the inputs from 2.1 and 2.2, will feed into the research agenda.

1.1 Objectives of WP 2.3

The objective of Horizontal Integration activity is to identify all the technologies that could successfully be introduced in the CH domain.

The process of gathering information in horizontal integration uses several techniques. Input comes from existing reports, studies and websites, technology watch channels and other EU projects. We also expect specific companies and network members to send us information, and we will attend major technology exhibitions.

Following the EPOCH guidelines, a lot of information on horizontal integration should be obtained through a "push" technique: by identifying potentially interesting companies and research institutes and inviting them to send in CH relevant product information whenever it becomes available, we should be able to gather a lot of information without major effort. The motivation for companies or research centres to make this information available is the possible inclusion in the Common Infrastructure. In some specific companies with a high potential, good relationships will be established with specific contact persons, typically product managers.

Within the network, a "Horizontal Integration Unit" is established by interested network members, who report technological developments that have - in their opinion - an integration potential in CH. Members of this unit will also give feedback and advice on horizontal integration issues.

Through existing studies, typical technology watch channels and major technology exhibitions, a Permanent Market Watch will be established. As we expect that most technological domains that are closely related to CH (3D, visualisation, ...) the focus here will be on specific domains which are insufficiently covered today (see NoE application areas), plus CH related domains such as tourism and education.

Permanent contacts with EU projects that have integration potential with CH will be made through liaison officers.
When appropriate, "technology partner" agreements will be made that will allow detailed information to be transferred under non-disclosure agreement conditions to allow proper evaluation of new technology, and to produce well-founded advice, within the constraints of the NDA's. The network could also serve as an entity that obtains licenses for certain major software platforms for evaluation, development and possible exploitation purposes, where appropriate. For example, some major software platforms for the mobile communications industry offer very interesting perspectives for CH, but their price level - targeted to telecom providers - is too high to allow cost effective use in CH. A network license at highly reduced price would not create any commercial distortion but offer interesting opportunities for monument, site and museum presentation.

From the inventory of potential technologies and the obtained expert advice a Cultural Heritage Integration Profile will also be created, with guidelines and best practices to integrate those technologies successfully in the CH domain.

1.2 Network partners involved in WP 2.3

- The Ename Center for Public Archaeology and Heritage Presentation, Activity Leader (Partner 3)

1.3 Link with other EPOCH Work Packages

Together with WP 2.1 and 2.2, the results of this Horizontal Integration will feed into the common research agenda (WP 2.5).

2 Permanent market watch

The approach towards a permanent market watch was set out in different ways:

- Internet search, reading technology watch reports, browsing manufacturer’s websites...
- Attending several conferences and exhibitions on CH and technology in general:
  - Museum & Heritage Show (London, UK): 12 May 2004
  - TILE trade (Maastricht, Netherlands): 17 June 2004
  - CASA (Geneva, Switzerland): 7-9 July 2004
  - ICHIM (Berlin, Germany): 31 August – 2 September 2004
  - Media elements (Enschede, Netherlands): 11 –12 November 2004
  - CAA 2005 (Tomar, Portugal): April 2005

2.1 Methodology
Trying to make inventory of all technologies that could successfully be introduced in the Cultural Heritage domain is not an easy task at this stage in the EPOCH project. It is a bit like trying to make a list of all the straws in the proverbial haystack, long before looking for the needle.

As the preliminary studies on user needs (WP 2.1 Stakeholder Needs) and the success factors (WP 2.2 Vertical Integration) are still in progress and the research agenda (WP 2.5) will only follow after this Horizontal Integration, it is hard to know where to start the technology review.

For this reason, part of this work package will take the shape of a website. This site is built as a weblog, or BLOG, a web technology that is proving very popular. A blog is like a personal journal on the web or, in our case, a collaborative scrapbook.

Our blog consists of a list of pointers to other web pages about technology, new products or developments. We will publish the most important articles in so called 'postings', explaining where this technology is going and give the URL’s to the original pages. Where appropriate, we will give our opinion about the integration potential in CH. The weblog entries are date-stamped, with the newest post at the top of the page.

The readers – the network members – on the other hand can comment the published postings. They will also be able to send us information, interesting links etc., by filling in a form and sending it directly from the site.

2.2 Critical Remarks

So far, we have limited ourselves to publishing – and in most cases analysing – all articles, reviews and uses of technology we have found. We have not researched particular subjects, but made a selection based on the relevance of the subject to CH. Also, we have not delved too deep into any subject – we will do this if a technology or application proves so useful it needs further investigation.

The focus and depth of research will improve when the research agenda is defined in WP 2.5.

This information repository will grow over time and will prove useful for the work packages that are to follow.

We have, as for the 2.2 work package, at least for now intentionally skipped all the technologies for data capturing and recording, warehousing (databases) or the preservation of artefacts: the different phases of the technology pipeline as described in WP 22.

We understand that this research has to be done as well, and it will be over the coming years.

Up to now, we have intentionally limited ourselves to those technologies that are – or could be – used in interpretation and presentation of cultural heritage to a general public or a specialised audience.
2.3 Thematic approach

In order to make our weblog usable and manageable, we had to divide all the postings into subjects.
We decided to follow a thematic approach.

Since we decided to deal only with heritage interpretation and presentation, we were able to distinguished 5 key themes around which to work.

From the definition that discovering and appreciating CH is all about sharing experiences, between individuals or in large guided group, and that this involves the human senses, play and interaction, the following subdivision emerged:

1. Sight
2. Touch
3. Hearing
4. Play
5. Personalisation

Sight regroups all the technologies about screens, projection, 3D etc. Touch deals with human interfaces, haptics and sensors Hearing lists techniques to produce sound, vibration or speech. Play is about games technology, interaction, etc. Articles on artificial intelligence, TTS will find a place here. Personalisation deals with access control, identification, localisation – and thus WIFI, RFID, GPS etc.

We are aware that once we start to include the other phases of the pipeline, our subdivision will have to be reviewed, or rather broadened to include data collection and processing, conservation and restoration, etc.

2.4 Preliminary Results

See http://horizontal-integration.blogspot.com/

For the purpose of this written report, a selection of articles that are (to be) published on the blog are printed below.
During our research, we have encountered a number of technologies that can clearly be earmarked as potentially promising in the world of Cultural Heritage.

Some of the things we saw were experimental, some are already applied technologies. In many cases, these technologies are commercialised as industrial applications, in retail or as consumer goods, or have reached the final development stage. We are convinced that the effort required to modify them so they could be used in the CH domain is probably relatively small compared to the cost of their initial development, requiring no more than the right content, interface and software integration.

Defining interesting concepts for their use – or combinations of different existing techniques into a new one – and balancing added value over cost, will be an interesting exercise for the technology integrators and museologists.

The biggest hurdle will probably be to convince the manufacturers and vendors to look at the CH sector and see a viable business case. As has clearly been identified in WP 2.2, museums, sites and monuments are in no way to be compared to the private industry. CH is not a rich market with big budget projects (with some notable exceptions). Many museums depend of a local or higher government and are therefore bound in their actions to a public tender. Usually this means that the firm with the lowest tender gets the job. This makes the development and sale of a technology, and certainly of a new or experimental technology, complicated and risky.

The following list and descriptions is by no means final or all encompassing. It is the tip of the technology iceberg we researched this year, and a selection of the best or most clearly defined applications we encountered.

### 2.4.1 Sight

Sight regroups all the technologies about screens, projection, 3D etc.

#### 2.4.1.1 3D Visualisation techniques

<table>
<thead>
<tr>
<th>There are a number of technologies available to view images in 3 dimensions.</th>
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<tr>
<td>In principle, all stereo 3D techniques share a common approach: 2 artificially created views are displayed the same screen: one for the right eye and a slightly offset one for the left eye. The brain puts both images together as one 3D picture.</td>
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<tr>
<td>The main problem with stereo imagery is making each eye only look at the image it is supposed to see. There are a number of techniques to achieve this result. The differences lay mainly in how image separation is achieved in practice.</td>
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<tr>
<td>Two techniques to view 3D without goggles are known since the 19th century. They involve the eyes to either cross or focus on a point behind the screen. This is called the parallel viewing method. But these techniques are hard to master, very tiring for the eyes and frankly not at all adapted to CH.</td>
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<tr>
<td>The old View-Master however is basically an assisted version of the parallel viewing method.</td>
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Although a bit old fashioned, and known mainly as toys, these View-Masters should not be completely dismissed as equipment to view 3D images of monuments or objects. If properly adapted, they offer a very cheap and efficient alternative to a 3D display.

Most techniques used to show a stereo image nonetheless require special goggles. These glasses all use different techniques to achieve the same result: to view two separate images of the same scene – one to each eye – so that the brain sees it as a one stereo (3D) image.

There are different kinds of goggles, each with their own characteristics, advantages and price. As a general rule, the better the technology, the more expensive the goggles and equipment is.

Goggles can be either of the passive or active kind, with anaglyph (i.e. lenses in different colours – red/green, red/blue or red/cyan) or polarized being the most common passive goggles.

**Passive goggles**

An **anaglyph** stereo picture starts as a normal stereo pair of images: two images of the same scene, shot from slightly different positions. One image is then made all green/blue and the other is made all red. The two are then added to each other.
When the image is viewed through the glasses the red parts are seen by one eye and the green/blue parts are seen by the other.

This effect is fairly simple to do with photography, and extremely easy to do on a PC. The main limitation of this technique is that because the color is used in this way, the true color content of the image is usually lost and the resulting images are in black and white. A few images can retain their original color content, but the photographer has to be very selective with color and picture content.

**Polarized glasses** are probably the most commonly used in amusement parks and alike. Each lens is polarized at an opposed 45 degree angle.

This setup requires two projectors, each with a polarized lens at an opposing 45 degree angles over it, like the glasses. The polarized lens lines up all the light waves so these are in one orientation. These can only pass through a polarized lens that is polarized at the same angle. If the polarization of the lens is different then it won’t let that light through. Light coming from the projector oriented at -45 degrees will be seen by one eye, and the light coming from the other projector oriented at +45 degrees will be seen by the other eye. Hence, a stereo pair of images can be displayed on the same screen and the viewer will see one single 3D image.

**Active goggles**

Active goggles or shutter glasses have LCD lenses which alternatively obstruct the right eye and then the left. The speed of the shutters is in direct relation to the refresh rate of the TV or computer monitor. Like the other techniques, it works with two slightly offset images for each image of video. LCD shutters cover or uncover each eye of the viewer in sequence, allowing one eye to see one image, then the other.

CRT or “Tube” type televisions are required for use with active 3D Video Viewing Systems. These types of televisions refresh their image in a very consistent frequency, which makes it very easy for the 3D system to synchronize to the signal.

HDTV, Plasma, LCD, and most projection television systems refresh their image in a random manner. This makes it impossible for the 3D active goggles to synchronize to their signal, making them incompatible with the system. The exception to this is 3 CRT based projection systems where all 3 colours have a synchronized refresh.
Using glasses to visualize 3D is cumbersome and we think not very well adapted to the domain of Cultural Heritage. The goggles are not very pleasant to wear, are in some cases costly, and some even need to be wired to a computer. They also have to be distributed to the audience and collected afterwards.

**3D visualisation without goggles**

**Auto stereoscopic screens**

New display technologies are being developed that allow images to be seen in 3 dimensions without the use of these goggles.

3D images are viewed on screens that employ a technique called a “parallax barrier”, an older but well known approach to generating a stereo image.

**For single users**

**Sharp** has developed a liquid crystal display that allows 3D viewing without the need for special glasses. [http://www.sle.sharp.co.uk/research/3d/3dbackground.htm](http://www.sle.sharp.co.uk/research/3d/3dbackground.htm)

The technology works by controlling the path of light so that slightly different images reach the left and right eyes. Each eye sees only the image intended for it and the brain combines the images and perceives them as a 3D representation. The 3D LCD combines a conventional LCD with a Switching LCD, a proprietary Sharp development. The screen is also electrically switchable, so users are also able to see 2D applications such as text and images.

![Diagram of 3D display modes](image)

These auto stereoscopic monitors are starting to appear in laptop computers too. Although they have the distinctive advantage of allowing the user to view 3D without glasses, these images can only be viewed from one or possibly a couple of so called ‘sweet spots’, where the parallax is respected.
The parallax barrier also cuts out some of the screen's brightness, and the image resolution is lower since 2 interlaced images are displayed simultaneously. This means that the applicability in CH is limited to research and object management, but does not lend itself very well to visitor presentation systems where several persons have to watch the object at the same time.

**For Multiple users**

**X3D-Technologies** [www.x3dworld.de](http://www.x3dworld.de)
This company produces 40” and 50” 3D Plasma screens. The system works in a similar way to the Sharp screen, but in a larger format. Their screens cannot unfortunately not switch between 3 and 2D images, and therefore not display text in an acceptable way. They are thus more appropriate to the visualisation of 3D virtual reconstructions of buildings or objects at large venues, fairs and exhibitions.

### 2.4.1.2 Wedge Display

CamFPD, [http://www.camfpd.com/](http://www.camfpd.com/), a spin-off from Cambridge University’s Department of Engineering, have fashioned the Wedge Display, a completely new flat TV concept relying on internal reflection.

The display uses rear-projection technology to cast images onto a screen. With an LCD projector at the end of a wedge-shaped piece of clear plastic, light is bounced through the length of the wedge until it reaches the angle at which it escapes the screen as an image.

This technology promises cheaper and extremely flat LCD projection TVs. From: [www.engadget.com](http://www.engadget.com)
2.4.1.3 Mini Projectors

Researchers are working on pocket-size projectors so that one day people will be able to see a high-resolution slide show right out of a camera, a cell phone or an organizer. These projectors are not meant for big screen projections in meeting rooms, but for personal use, with screen the size and brightness of a laptop screen.

Other applications may include expanded control panels cast on surfaces for PDA-like devices.

Some projectors are based on light-emitting diodes while others use laser-light. The problem with virtually all of them is power consumption. Recent competing technologies however are stirring some competition to be first to market.

We are not sure if these personal mini projectors could be used in CH, but think the technological developments should be followed up closely nonetheless.

Below is a good article from the NY Times.

New York Times, November 4, 2004
WHAT’S NEXT
For Your Viewing Pleasure, a Projector in Your Pocket
By ANNE EISENBERG
E-mail:Eisenberg@nytimes.com

It takes squinting and guesswork to make out the details of postage-stamp-size snapshots displayed on cellphones and digital cameras. But researchers are working on pocket-size projectors so that one day people will be able to see a high-resolution slide show right out of a camera, a cellphone or an organizer.

In the future, the miniprojectors may also be attached to DVD players, so people can watch a movie with a TV-quality picture on a nearby wall.

Most standard digital projectors are bulky. Even the trimmest video projectors used for office presentations have the dimensions and the weight of a telephone book. But prototypes of a new generation of miniprojectors, including ones only slightly thicker than a credit card, have been developed, some based on light-emitting diodes, others on lasers.
"There will probably be two or three different technologies for miniprojectors that will coexist," said V. Michael Bove Jr., who has developed a prototype. Dr. Bove is director of the consumer electronics research project at the Media Lab at M.I.T.

"The important point is that whatever the technology, there are going to be significant differences from present office video projectors and projector TV's," he said.

For example, future miniprojectors designed to be embedded in other devices may be used to cast images like control panels or maps onto a car dashboard.

"They are going to radically alter the way we work with projectors when you can download a map onto a phone and point the projector at a surface to get a higher-resolution image," Dr. Bove said.

There are still problems to solve before inexpensive miniprojectors the size of sugar cubes roll off the assembly line. "It's going to take a while to make the projector design efficient," he said. Power consumption is an important issue since in many cases the projector would draw power from the cellphone or whatever device it is coupled to.

At present, Dr. Bove said, projection TV's and video projectors can use hundreds of watts of electricity, but only a couple of watts at most will be available when they are powered by batteries in hand-held devices.

Because of the challenges, Dr. Bove predicted that before the projectors are fully miniaturized, the earliest versions would appear as attachments to laptops. "There's more room and power on a laptop," he said. "Eventually, though, they will find their way into hand-held products."

At Mitsubishi Electric Research Laboratories in Cambridge, Mass., Ramesh Raskar leads a group that has demonstrated a pocket-size projector meant one day to attach to cellphones, digital cameras or organizers.

Lumileds Lighting, a company based in San Jose, Calif., that makes extremely bright light-emitting diodes, has also developed a prototype for a compact projector. Steve Paolini, director of business development, said it was meant not for big-screen displays in meeting rooms, but for personal uses. "Our initial goal was a screen the size of a piece of paper," he said, "with the size and brightness of a laptop screen."

The Lumileds projector is not for sale; it was built, Mr. Paolini said, to demonstrate the power of light-emitting diodes. "But there's no technical reason why pocket projectors can't be built now," he said. "It's a market issue."

Lasers rather than L.E.D.'s are the basis for a hand-held projector in development at Light Blue Optics, a company in Cambridge, England. "We want a device that you can download films to, press a button and see a huge screen projection," said Adrian Cable, director of the company.

The large projections are produced holographically. "These are not the three-dimensional holographic projections of Princess Leia in 'Star Wars,' " Dr. Cable said, but instead two-dimensional ones produced by an optical process different from standard projection.

Dr. Cable, who has a doctorate in holographic optics from Cambridge, said the basics of projecting video holographically have been known for 20 years. In it, light is forced to propagate not in straight lines but through small gaps that force it to diffract. Precise control of this diffraction can produce holographic images.
"Historically, images projected holographically have tended to be grainy and poor in quality," Dr. Cable said. And even when the images were acceptable, the computational problems involved in calculating the holograms were time-consuming. "It used to take 20 minutes to calculate the hologram for one video frame," he said.

But the Cambridge group's work has resulted in improvements in image quality and processing speed, he said. "It's much simpler to form an image holographically," he said. "You need smaller and fewer lenses, leading to a smaller projector."

At Mitsubishi Electric, Dr. Raskar and his group have developed several methods to demonstrate how people will interact with projector images in the future. For example, they have developed a method to stabilize the projected image so that once it is fixed on a wall it will not move with subsequent hand movement. Then they developed a way to click and drag items within the projected image from one place to another, using a game of tick-tack-toe projected on a wall as an example.

"Now you can actually interact with the projected contents," he said. "You point where the piece is, and then drag it to where you want it to go."

Mr. Paolini of Lumileds also thinks that game playing is in the miniprojectors' future. When he took one of the prototypes home, he said, his son started playing with it on his bed, aiming it at the walls.

"Think of it," Mr. Paolini said. "You can play games on the ceiling."

2.4.1.4 Prototype 3D holographic video calls

Researchers in Japan are showing off a technology called the SeeLinder that lets you make 3D holographic video calls.

SeeLinder uses a 360-degree digital camera and cylindrical tube to create a real-time 3-dimensional hologram that shows the person you're talking to from almost any angle.

By comparison, most 3D displays have a sweet spot that only gives the full 3D effect when looking at the screen from a specific point.
Although these screens are still at the prototype stage, we think that any technology that allows 3D objects to be seen from any angle will find its way to museums. Compared to the other 3D screen technologies that are described in this chapter, these images can be seen by a large audience, not just one person at the time, and do not require the user to wear special goggles.

From [www.endgadget.com](http://www.endgadget.com)

### 2.4.1.5 Everywhere Displays

The Everywhere Displays project by IBM aims to develop a system that allows the transformation of every surface in a space into a projected "touch screen".

The prototype combines an LCD projector, a pan/tilt mirror and a camera. The mirror is used to deflect the image of the projector to any surface – walls, a table or the floor of a room. The projected image is processed to compensate for the perspective distortion.

A pan/tilt video camera detects hand/body activity on the projected area, so the user can interact with the projected image by simply touching the surface, resulting in a touch screen on virtually any surface.

IBM list a number of possible uses for their Everywhere Display, such as a general display where the projector is used to create a display on any surface, or an interactive whiteboard, projecting an image on a wall for group viewing. According to IBM, their system could also be used for notification, showing location specific information, signaling and as a deviceless remote control.

They list their potential users as offices, education and retail. The Cultural Heritage domain could be added to that too.

We could think of a lot of interactive museum applications that would take advantage of the possibilities that are offered here.

2.4.1.6 GPS-Ready Digital Camera

http://biz.yahoo.com/prnews/050119/nyw185_1.html

The Ricoh Corporation introduced the Pro G3, a high-resolution digital camera that embeds captured images with GPS coordinate information received from either its on-board GPS unit or from external GPS devices. Once these captured 'geo-images' are transferred to a PC, they are automatically converted to shape files or merged to geo-databases for instant integration into Geographic Information Systems (GIS). Points representing each image's position may be hovered over to display a thumbnail, or clicked on to access the full-size image.

In addition to storing GPS data in the image, the camera also utilizes a user-configurable data dictionary for tagging pictures with workflow-related information. These attributes are easily accessible from the GIS layer table for automated database integration.

Archeologists in Maine use these cameras to scout out archaeological sites; Universities, National Park personnel, farmers, and even museums are finding that their GIS workflows have been optimized since adopting the camera.

2.4.1.7 Taking photos from a kite

Here is a cheap and easy way to take aerial photos of an archaeological site or monument: modify a digital camera and fly it up a kite to take photos. The results look pretty good and you can do this with just about any digital camera.

Click http://digitalcameras.engadget.com/entry/1757766119821744/ to read more.

2.4.1.8 Electronic paper

Digital or electronic paper has for a long time now been described as the best way to visualize digital information with the ease of use and functionality of paper, but it took almost 30 years to develop the technology into usable paper like devices.

Electronic reusable paper is a display material that has many of the properties of paper.
It stores an image, can be viewed in direct sunlight, has a wide viewing angle, is flexible, and is relatively inexpensive, but, unlike conventional paper, it is electrically writeable and erasable.

Although projected to cost somewhat more than a normal piece of paper, a sheet of electronic reusable paper could be re-used 1000s of times. This material has many potential applications in the field of information display including digital books, low-power portable displays, wall-sized displays, and fold-up displays.

2 Companies – E-ink and Gyricon – develop and market products. Both use a different technological approach and their products have different applications: E-ink as electronic books and Gyricon as pricing and promotional display in retail environments.

Electronic books by Philips and Sony using technology by E-ink

Advantages of electronic paper over more conventional electronic display systems such as TFT screens include light weight and high contrast, with text and images that can be viewed in strong or dim light, and low power consumption (there is no need for external power to maintain an image). These screens are thus extremely well adapted to outdoor use.

Sheets of electronic paper are light and flexible and could easily be carried around during a museum tour or the visit of a historical monument.

These screens could be integrated into PDA-like devices, making these ideal for portable cultural heritage presentation systems. They could include the same technological add-ons such as GPS and W-lan, so that text information and images could be updated constantly, according to the location of the user.

http://www.eink.com/news/releases/pr70.html on electronic reading devices
2.4.2 Touch

Touch deals with human interfaces, haptics and sensors

2.4.2.1 Touchscreens

There are currently 5 touchscreens technologies, based on different types of sensors.

1. **Capacitive**: A tiny current is fed into a conductive coating within a glass sandwich from busbars at the edge of the glass. The current leaks to the ground through the finger and electronics determine the x-y position in relation to each of the busbars.
2. **Resistive**: a flexible layer with conductive coating on one side is brought into contact with a rigid layer to form a circuit with a varying resistance. An x-y position is measured by voltmeter drop from each of 4 busbars at the edge. This is the type of screen used in PDA’s.
3. **Projected Capacitive**: almost-invisible wires laminated in a tough glass substrate project an electrical field on the surface of the glass layer. A finger touching the front surface affects the field. The decoder calculates the X-Y co-ordinates from this and relays commands to the host system.
4. **Surface-Acoustic Wave**: exciters around the edge of a layer of glass set up vibrations on its surface. Touching the glass causes a shadow which is detected by receivers also around the edge. SAW can also detect pressure giving a z-axis reading.
5. **Infrared**: this is one of the oldest techniques to build a touchscreen. It works with a matrix of LED’s and diodes that are placed in front of the screen.

Each system has its advantages and disadvantages, and therefore most appropriate use. The type of touchscreen is thus very dependent on the application, environment and budget.

See also [http://www.tridentdisplays.nl/about.html](http://www.tridentdisplays.nl/about.html)

2.4.2.2 Zytronic [http://www.zytronic.co.uk/touchscreens_zytouch.htm](http://www.zytronic.co.uk/touchscreens_zytouch.htm)

Zytronic, a company in the UK, manufactures large format touchscreens for TFT and Plasma monitors. These work on the projected capacitive principle. The glass can be up to 25mm thick and since the sensing components are well away from the touch surface the system is extremely rugged.


The Everywhere Displays project from IBM Research aims to develop systems that allow the transformation of every surface in a space into a projected “touch screen”. The interactive component works with image recognition. A camera follows the position of the hand and finger and can recognize a ‘mouse click’.

2.4.2.4 Haptic devices

An EPOCH showcase researched the devices that could successfully be used to interact with the virtual 3D replica of a historical artefact. A number of them were tried, and one was selected for its ease of use and 'intergrability'.
Besides their technical differences, the haptic devices are defined by their degrees of freedom.

6 Degrees Of Freedom or DOF means 3 rotational axes + up/down, left/right and forward/back.

For our showcase, we were looking for a simple physical interface between the user and a multimedia presentation that would be easy to integrate, robust and simple to use. It could best be compared to a ‘spaceball’ or a base less joystick, and give 3 DOF, as we were only interested in being able to rotate the model.

These are the ones we looked at:

**3D Mouse**

A 3D Mouse such as a ‘Wanda’ is a navigation device with a joystick and 3 programmable buttons. They can be used to manipulate 3D objects in a virtual environment. With an embedded 6 DOF sensor, it can be used in free space, unlike a typical mouse or joystick.

**Joysticks**

A joystick is a 3 DOF device that works with the tilting motion of the hand. It is used in gaming as well as in the industry or in medical applications.

This ‘CyberStick’ is a base-free joystick designed specially for Virtual Reality.

**Haptic or data gloves** are gloves equipped with sensors that sense the movements of the hand and interface those with a computer.

They can also feature small vibrotactile stimulators on each finger and the palm of the hand. The array of stimulators can generate simple sensations such as pulses or sustained vibration, and they can be used in combination to produce complex tactile feedback.
patterns.

**Force feedback gloves** are lightweight, force-reflecting exoskeletons that fit over data gloves and add resistive force feedback to each finger. With the force feedback system, users are able to explore the physical properties of the computer-generated 3D object they manipulate and literally “feel” the object. They also allow the operator to control a remotely-located robotic “hand”.

The grasp forces are exerted via tendons that are routed to the fingertips via the exoskeleton. They can be programmed to prevent the user’s fingers from penetrating or crushing a virtual object.

Force feedback gloves are however very expensive at about 35,000€.

**Mechanical Tracking Devices** measure position and orientation by using a direct mechanical connection between a reference point and the target. Typically, a light-weight arm connects to a control box, and encoders placed at the joints of the arm measure the change in position and orientation with respect to the reference point.

**Optical tracking devices** or wands come in all shapes and variations. Most incorporate on-off buttons to control variables in a simulation or in the display of data. Others have knobs, dials, or joy sticks.

Their design and manner of response are tailored to the application. For example, biologists sometimes use wands like scalpels to slice tissue samples from virtual brains.

The object to be tracked is equipped with retro reflective markers. Tracking cameras recognize these markers. The data
from these cameras is then processed, the result is the coordinates of the markers, and hence the position of the body carrying the markers.

Most wands operate with six degrees of freedom.

**Spaceball**
A spaceball is a 6 DOF motion controller that can zoom, pan and rotate models. It feels very much like holding the model in your hand. The controller has sensors built in that feel the movement and the amount of pressure applied controls the speed.

**Motion sensor**
A motion sensor is a 3 DOF sourceless tracking device. It provides a full 360° range and has no line-of-sight restrictions. It gives 3 rotation axes, i.e. angular coordinates.

The device connects to a Windows PC via the USB port. Windows control and connectivity software provides sensor configuration, network interface and joystick emulation. Motion prediction, adjustable rotational sensitivity and control of output data filtering allows fine tuning for our specific application.

This is the device that was used for the showcase.
2.4.2.5 Responsive handheld object

Moments of Grey is the outcome of a speculative project that researched and developed prototype responsive objects which attempt to evoke what might be found near the sea. As children most people have listened to the sea in a shell on the beach. This project is exploring this type of experience with an object on found a beach, to create an almost magical object that is made alive by technology.

Each object contains a basic single chip computer, sound chips, leds, light sensors and an accelerometer and is made of polyester resin, foam and other material.

In a gallery the work is placed on the floor on a circle of foam; the user picks the objects up, touches and plays with them, rolls them around in their hands and strokes them, like they would stroke a found object on the beach. The objects respond by glowing and playing sounds of water and the beach environment.

Although both the aim and the outcome of this project are different, this responsive object can somehow be compared to the result of the EPOCH showcase Multimodal Interface for Safe Presentation of Valuable Objects. Both strive to show the symbolic information hidden within the object.

2.4.2.6 Anywhere interactive interface

A Paris-based company called Sensitive Object developed a technology that turns any rigid surface or object into a keyboard or an interactive interface. Using a single inexpensive sensor, it detects finger taps on a shop window or a blackboard and can calculate the exact position of the tap, translating those into mouse clicks or keystrokes.

The system can work with a surface as large as four square meters, and the number of "keys" can reach 544.
It allows for a wide range of interactive applications such as shop windows, public places, education, leisure and arts.
The technology has already been tested in a Paris shop selling lamps where 8 tactile buttons, indicated as small white circles, were pasted on the interior of the window shop. Passer-bys can, with a simple touch, activate the different lamps.

If it works as well as advertised, this interfacing mode could be easily transferred to museums in the shape of interactive display cases – supposing the staff can stand the noise of fingers tapping the glass.

Via near near future http://www.we-make-money-not-art.com/

2.4.2.7 Virtual Keyboard

A virtual keyboard projects a full-size virtual keyboard onto any surface.

The Virtual Keyboard uses laser light to project a full-sized computer keyboard onto almost any surface. The virtual keyboard behaves exactly like a real one. An infrared based optical recognition system calculates which of the keys the finger taps. The system is very easy to use and is accurate as long as the fingers are held 2 mm above the surface between key presses. Although there is no tactile feedback, audible key clicks can be turned on in the software.

The virtual keyboard connects to compatible PDAs, Smartphones, laptops or PCs via Bluetooth and provides a practical way to do email, word processing and spreadsheet tasks. The receiver is approximately the size of a cigarette lighter and has a rechargeable battery.
This virtual keyboard technology would make a good tamper and vandal proof interface for museums or on site presentation systems if integrated into the console, in places where the ambient light is not too strong.

### 2.4.3 Hearing

Hearing lists techniques to produce sound, vibration or speech.

#### 2.4.3.1 Parametric loudspeakers

http://www.atcsd.com/
http://www.holosonics.com/

<table>
<thead>
<tr>
<th>Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parametric Loudspeakers provide the ability to direct music or voice from an audio source into a tight beam, much as a lightbeam from a flashlight. Only those within the virtual column of sound can hear the sound – outside the beam the sound is virtually inaudible.</td>
</tr>
</tbody>
</table>

The parametric loudspeaker is a new technology for to the reproduction of sound. It is very different from the conventional ‘omnidirectional’ loudspeaker, and offer significant potential for CH application.

<table>
<thead>
<tr>
<th>What it does</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sound generated by a parametric loudspeaker can only be heard when standing directly in line with the speaker or after it has reflected off a hard surface. For example, if the ultrasonic emitter is pointed toward a wall, the audible sound will only be heard after it has reflected off the wall, and will seem to come from that wall. This is similar to shining a flashlight at a wall in a dark room. For stereo, a separate ultrasonic emitter is required for each channel of audio, one for the left channel and one for the right.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How it works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parametric loudspeakers use a beam of ultrasound to carry the audible sound waves. The directivity or narrowness of any source producing sound waves depends on the size of the source, compared to the wavelengths it generates. Audible sound has wavelengths ranging from a few cm to several meters, and because these wavelengths are comparable to the size of most loudspeakers, sound propagates omnidirectionally. A narrow beam can only be created by having a sound source that is much larger than the wavelengths it's producing. Clearly, having a loudspeaker twenty meters wide is not very useful.</td>
</tr>
</tbody>
</table>
Ultrasound on the other hand, whose wavelengths are only a few millimeters long, are much smaller than the source, and consequently travel in an extremely narrow beam. Of course, ultrasound, which contains frequencies far outside the range of hearing, is completely inaudible. But as the ultrasonic beam travels through the air, the inherent properties of the air causes the ultrasound to distort (change shape) in a predictable way. This distortion gives rise to frequency components in the audible bandwidth, which can be accurately predicted, and therefore precisely controlled.

By generating the correct ultrasonic signal, essentially any sound desired can be created within the air itself.

Note that the source of the sound is not the physical device, but the invisible beam of ultrasound which can be many meters long.

**Components**

Currently, 2 companies manufacture loudspeakers using this technology, both in the US: Holosonic Research Labs, Inc., of Watertown, Massachusetts, who calls it the Audio SpotLight, and American Technology Corporation from San Diego in California, who named it Hyper SonicSound. This last product is also distributed under license by RSF in France and by Sennheiser in Germany.

The complete sound system consists of the following components:
- an audio source, such as a CD player, a PC or a microphone,
- a signal processor
- an ultrasonic amplifier
- an ultrasonic emitter or transducer

Depending on the manufacturer, the ultrasonic amplifier/signal processor will either be separate or integrated within the transducer.

The audio source is converted to a complex ultrasonic signal by the signal processor before being amplified and emitted into the air by the transducer.

A single transducer with its own signal processor and amplifier costs between 1500 and 2500€ (in august 2004). As with any new technology, prices are expected to drop in the near future.

There are of course some limitations to this technology. High frequencies are better transmitted than low frequencies. This means that speech works very well but (modern) music less.

The beam is relatively narrow (about 1m in diameter), so large groups can not be addressed, but then conventional speakers are probably more appropriate.

One real drawback is that in order to carry an audible soundwave, the ultrasound has to be about 20% louder than the audiotrack. When used for a long time, the ultrasound speakers might thus cause headaches.
What is the potential for CH
This technology could easily be applied to the CH domain.
The most obvious use is to provide audio commentary near an exhibit, without spreading sound to others visitors nearby, without headphones and much more effectively than obtrusive 'speaker domes'.
The narration about a specific display can be directed only to the people standing directly in front of it. The audio could also be projected in different languages, from a single central device.

Part of this information was compiled from the websites of Audio Spotlight http://www.holosonics.com and American Technology Corporation http://www.atcsd.com

2.4.3.2 TEXT TO SPEECH

Text-to-speech (TTS) is the generation of synthesized speech from text. The goal is to make synthesized speech as intelligible, natural and pleasant to listen to as human speech and have it communicate just as meaningfully.

TTS can also be combined with avatars, a technology that is demonstrated in one of the EPOCH showcases: Avatar Based Interactive Storytelling.

Software such as Oddcast's VHost SitePal™ allows the user to create speaking animated characters (avatars) for a web site, and add an audio message via Text-to-Speech or voice recording. http://www.oddcast.com/sitepal/

2.4.4 Play

Play is about games technology, interaction, etc. Articles on artificial intelligence, TTS will find a place here.

2.4.4.1 Avatars

A couple of Text-to-Speech-to-Avatar applications have appeared on the web at http://www.pulse3d.com/pulse/ and http://www.oddcast.com/sitepal/

Both let one use either a recorded voice or use the sites own TTS application and allow the user to choose a character as the avatar. The Pulse3D application even lets him animate his own 2D image – a picture form a person and even an animal, object or drawing – into a talking avatar. Demo's can be made on both websites.

These are the best avatar applications we have seen so far, and offer great potential for interactive websites and kiosk applications.
What differentiates these web applications from the avatars we have seen at conferences this year, namely ICHIM and CAA, is how easy it is to build characters and input speech. They make the animation of virtual characters accessible to everyone, and require no IT knowledge whatsoever.

Although these all-in-one solutions are not built for the CH domain, they could very easily be adapted (if necessary) to be used in for example site presentation systems. Using artificial intelligence, they would even allow a good degree of interaction with the visitor, who could ask questions to a virtual guide and get spoken answers.

### 2.4.4.2 Portable Media Centers

A Portable Media Center is a universal media player based on Microsoft’s Windows Mobile, that let the user take all digital video, music and photos from his PC wherever he goes.

These devices play video, music and pictures transferred from a computer or downloaded from the internet, including Windows Media Video, Windows Media Audio, Windows Media Image, MP3, JPEG and TIFF files.

In comparison, MP3 players only play music.

Because Portable Media Centers will use smart synch technology that is available in Windows Media Player, the user will be able to transfer the content of the Windows Media Player media library to the device. This includes music copied from a CD, pictures from a digital camera, home movies from a digital video camera, TV shows recorded using a Media Center PC or other personal video recorder applications and videos downloaded from the Internet. In addition, Portable Media Centers will play downloaded digital music and video, including over 500,000 WMA tracks from leading music services including Napster, Best Buy, Buy Music, Music Now and many more, and movies from content providers such as CinemaNow.

The entertainment will be easily and automatically transferred to the Portable Media Center using smart sync technology delivered in a future release of Windows Media Player. Smart sync technology will enable automatic, intelligent synchronization of music with next generation portable music players as well as synchronization of music, photo, TV content, and movies with Portable Media Centers.

Portable Media Centers will be available for purchase in the second half of 2004.

Microsoft is working with leading consumer electronics manufacturers to revolutionize the way people experience personal entertainment on the go. Creative Labs, iRiver,
Samsung, Sanyo and ViewSonic have all announced that they will be making Portable Media Centers.

Portable Media Centers will work with any version of Windows XP, including Windows XP Home Edition, Windows XP Professional Edition and Windows XP Tablet PC Edition. Portable Media Centers will also work with Windows XP Media Center Edition, allowing the user to take all of the recorded television shows recorded on a Media Center PC to enjoy anywhere.

Hardware partners are developing Portable Media Centers with storage capacity ranging from 20GB to 40GB depending on the manufacturer and model. A 40GB hard drive can hold up to 175 hours of video, over 600 hours of music or 100,000 pictures with all disk drive space dedicated to either video, audio, or pictures.

At the time of writing, a portable media center is expected to cost between 500 and 700 USD

2.4.4.3 Tablet PC thin client

A company called Motion Computing has converted their standard Tablet PC into a thin client device.

A thin client is a PC without a hard disk: all the information is kept on a central server, accessed through a wireless network. The PC has been developed in collaboration with the healthcare, retail and manufacturing customers of the manufacturer.

The standard tablet PC’s hard drive is replaced by a 512 MB flash storage device that only contains the Windows XP Embedded OS and a limited number of essential applications. The system also has a 12.1-inch XGA TFT LCD screen.

Large screen Tablet PC’s are starting to appear in some museum exhibitions and site visit presentation systems. They offer a larger screen and wider viewing angle compared to hand held PC’s (palms), allowing for an easier collaborative group visit. They are also very well suited for guides in museums who can easily show images and animations, or zoom into details, to a large audience. Tablet PCs would effectively replace the paper photographs and drawings guides often carry around, and give them innovative ways to interact with the visitor.

The advantage of thin client computing, with application and data on a central server, is centrally managed administration, high system reliability, data security and networked data access.

These PCs retails for approximately 1700 USD.

2.4.5 Personalisation

Personalisation deals with access control, identification, localisation – and thus WIFI, RFID, GPS etc.

2.4.5.1 RFID

Radio frequency identification, or RFID, is a generic term for technologies that use radio waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and perhaps other information, on an RFID tag.

The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed onto computers that can make use of it.

An RFID system consists of a tag, which is made up of a microchip with an antenna, and a reader with an antenna. The reader sends out electromagnetic waves. The tag antenna is tuned to receive these waves. A passive RFID tag draws power from field created by the reader and uses it to power the microchip’s circuits. The chip then modulates the waves that the tag sends back to the reader and the reader converts the new waves into digital data. An active RFID tag has a battery, which is used to run the microchip’s circuitry and to actively broadcast a signal to a reader.

Active tags have a long range of typically 30m, where passive tags have a short read range of less than 6m. These are on the other hand far less expensive than active tags and can be disposed of with the product packaging.

A lack of standards and cost has so far prevented RFID to be more widely accepted. Tags themselves are not very expensive at about 0,5€/pc, but for the retail market this makes them impractical for identifying millions of items that cost only a few Euro. Readers cost 500€ and more.
International standards have been adopted for some very specific applications, such as tracking animals. Many other standards initiatives are under way.

RFID’s are currently used mainly for tracking goods in the supply chain, in retail, by laundry rentals and in libraries. RFID is also used for security and payment systems. See www.rfidjournal.com

There are different workgroups, mainly focussing on retail applications. None, as far as we know, revolve around CH. http://www.rfidnederland.nl http://www.vil.be/nl/

In libraries RFID is used primarily to automate the book handling process including checkout, inventory maintenance, and check-in. When combined with automatic or Computer Assisted sorting equipment, RFID facilitates and speeds up book sorting. RFID tags replace both the bar code and EAS (anti-theft) device, allowing for much faster conversion of library materials in new branches. In existing libraries, RFID tags can co-exist with existing EM anti-theft systems. Check-out stations can be automated with easy, intuitive interfaces Book returns can be automated with check-in, EAS activation, and systems updates completed simultaneously at the book return chute. Fast on-the-shelf inventory allows for much better accuracy in collection management and increased book turns resulting in reduced book purchasing. This allows libraries to expand their collections without increasing their budgets. Source: Tagsys http://www.tagsys.net/

In museums and archaeological sites, RFID has promising uses.

One is collection management. Usual collection management methods have many risky moments. When an object needs to be identified, it has to be touched, lifted or tilted. This handling is not only very time consuming, it can also damage the artwork. Putting RFID tags on the items in a museum removes this risk by taking away the need to physically touch the object. There are other advantages to this system as well, which include: simplification of registration checks; integration in disaster planning; the possibility to store information in the tag and the combination with public information systems.

Another promising application for RFID is visitor identification & profile definition, and RFID triggering of multimedia kiosks, taking into account the said visitor profile. The content of site presentation systems can automatically be configured according to the language, age or personal interest of the visitor. Also, his behaviour can be monitored – the time spent reading the contents, the information he missed out – so the visit can be optimised, thus improving client satisfaction.

One example will be showcased in Work Package 2.4: Cultural Routes. A current application combining RFID and W-LAN is shown in the Natural History museum of Aarhus. The exhibition was visited on 20 October 2004
2.4.5.2 RFID and W-LAN

TAGGED X

Naturhistorisk Museum in Århus http://www.naturhistoriskmuseum.dk/

Jan Bender
Lau Rasmussen
Peter Laustrup
Henrik Sell

Cordura A/S
Museum inspector of the museum of Natural History

The Naturhistorisk Museum in Århus is one of the 4 Natural History museums in Denmark, and is located in the city of Aarhus, in the Danish region of Jutland. It receives 80,000 visitors a year.

The TaggedX system is a joint development between the museum, a private company called Cordura and Innovation Lab – an IT think-tank organized by the county of Aarhus, the city of Aarhus and TDC, the biggest telephone operator in Denmark, which promotes and sponsors innovative projects.

TaggedX was used for the first time during the last six months of an exhibition on birds, which ended in August 2004. This was used as a proof of concept. Now on its second implementation, TaggedX became an integral part of a temporary exhibition called Lívsförner (live forms). It is to be used for the whole duration of the exhibition, which opened in September 2004 and will last until February 2006.

The exhibition deals with the evolution of living animals and plants and is mainly targeted at children aged 10 to 12.

TaggedX is a PDA (personal digital assistant) based information system that uses a combination of Wi-Fi and RFID to offer location based content. The information is delivered to the visitor when and where it is needed.

The visitors (usually classes divided into groups of 3) receive a PDA when they enter the museum. They have to enter their e-mail address into the server; this is then linked to the PDA. The login and password they will receive by e-mail will later allow them to log into the museum webserver and access a personal web page containing post visit information. This includes the same information that they saw in the museum, extra information about the items that were studied. The personal page remains active for a period of 3 weeks after the visit.
RFID tags are mounted behind the information panels; their position is shown by coloured dots (note that it was the exhibition designer who did not want the tag to be better identified). These are short range tags costing about 2€ a piece. The 150€ RFID reader is slotted into the CompacFlash slot of a Siemens PDA of about 500€. It has a reach of approximately 5 cm, so in practice has to almost touch the text panel in order to identify the tag. This proximity offers the benefit to allow tags to be placed near each other. It also positions the user precisely inside the exhibition room.

The data is wirelessly transmitted in real time to the Wi-Fi enabled PDA. Although not strictly necessary – all the data could be kept on a CF card in the PDA – this system allows:

- all the data to be kept in one central database on the museum server. Only one system needs to be updated.
- visit information to be wired directly to the personal webpage of the user. He is thus able to retrace his whole visit and access all the data from home or the classroom.
- general statistical information to be gathered easily. This could be a record of all the tagged items the user has seen, the number of correct answers etc. This could be used by the museum to improve the layout of the exhibition if important parts are overlooked, or modify the questions.

Note that all this could also be achieved when docking the PDA’s to recharge the batteries after use.

At the entrance of the exhibition a choice of operation mode has to be made: game, encyclopaedia or English.

- The ‘English’ mode shows the translation of each text panel – which are in Danish – on the PDA. This way, the look of the panels is not cluttered by too much text and the typeface can be bigger.
- Encyclopaedia mode shows extra information on a given subject, together with animations or short movies.
- In game mode, questions have to be answered based on hints given by the PDA – such as ‘find an insect that has mimicked the colour of another one to protect itself’. When the right answer is found, extra contents such as film fragments are shown on the PDA screen.

The PDA’s are given back upon leaving the exhibition hall.

Currently, the use of the PDA’s is not charged extra. The reason is that the application is not yet completely reliable – the server needs to be rebooted a couple of times a day –
meaning the application is off line for about 10 minutes. The museum conservator has not yet decided whether the PDA application will be charged in the future, or be considered free added value to the visit.

In all, TaggedX is a relatively inexpensive technology that adds an element of edutainment into the visit of the Natural History museum. It is well received by the visitor and the feedback is positive. The biggest cost was the creation of the database content, which was done by museum staff. Note that their work is not yet finished, and that more information will be added to the database over time.

2.4.5.3 The MagiCook Kitchen

The MagiCook Kitchen from Little Tikes (http://www.littletikes.com/toys/) is a toy kitchen where all the fake food comes embedded with Radio Frequency ID tags. Swipe a plastic waffle over the built-in reader in the fake stovetop and you'll hear a variety food and cooking-related phrases.

RFID's are primarily designed to identify goods in retail applications or people in security systems. This must be the first time they are integrated into a toy.

One could imagine educational games for museums based on the same technology, such as children discovering the relation between different objects, pictures or paintings, or interactive applications linking artefacts with stories or sound.

2.4.5.4 Visitor Identification

<table>
<thead>
<tr>
<th>Theme park takes visitors to RFID-land</th>
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<tbody>
<tr>
<td>A Florida theme park is helping parents keep track of their kids by giving them wristbands embedded with high-tech radio signal technology.</td>
</tr>
<tr>
<td>Wannado City issues the radio frequency identification (RFID) wristbands to all visitors as part of general admission to the park, according to a release from Texas Instruments, the maker of the wristbands. The theme park opened last month in the Fort Lauderdale area.</td>
</tr>
<tr>
<td>The wristbands contain special microchips, or RFID tags, that wirelessly signal their whereabouts to reading devices throughout the 140,000-square-foot facility. Visitors can locate other members of their group by using touch-screen kiosks throughout the park that are linked to the system, called SafeTzone's Real-Time Locating System.</td>
</tr>
<tr>
<td>People have used RFID technology for years to track and identify livestock and lost pets. More recently, it has been put to use to monitor humans, and hospitals and prisons have begun to use RFID wristbands to keep tabs on patients and inmates.</td>
</tr>
<tr>
<td>One company, called Applied Digital Solutions, is even experimenting with injecting RFID chips into people's arms. Mexico's attorney general grabbed the headlines last month</td>
</tr>
</tbody>
</table>
when the Mexican government announced he'd been injected with the company's chip to give him access to high-security facilities. The country is also studying the technology as a tool for combating kidnappings.

Businesses are finding new uses for RFID technology too. Wal-Mart Stores, Albertsons and dozens of other major retail chains and consumer goods manufacturers are slapping RFID tags onto merchandise with the hope that the technology will help them juggle inventory efficiently. Pharmaceutical makers are examining RFID systems as an antidote to the counterfeit drug trade. Texas Instruments said it and its partner RF Code have installed the SafeTzone’s Real-Time Locating System tracking technology at Paramount’s Great America in Santa Clara, Calif., Wild Rivers Water Park in Irvine, Calif., Dollywood’s Splash Country in Pigeon Forge, Tenn., and Wet 'n Wild in Las Vegas.

LegoLand in Denmark is using similar technology to reunite kids separated from parents at its amusement park.

2.4.5.5 Bicycle mobile phone

According to Siemens, this rugged ‘outdoor’ mobile phone is designed for people with an ‘active lifestyle’. With their optional Bike-o-Meter, the handset can be mounted on a bicycle’s handlebar. It then displays not only standard cyclometer functions information such as speed and distance, but also gives the user the option to record own tours on the move or to follow predefined trips that are indicated on the phone’s display. The phone also has a built-in VGA camera for digital imaging and video recording on the go.
With the right content, a phone like this looks like an interesting interface for outdoor visits to monuments or 'cultural routes'. As with any portable device used in CH however, any system integrator will have to take into account the cost of the equipment and the renting and collecting of the phones. It might be easier (and cheaper) to devise systems that use the portable devices the visitors already possess, such as their own mobile phones.

http://communications.siemens.com

2.4.5.6 Mobile access

Access to cultural heritage information through mobile phones has good potential. Everyone has one and knows how to use at least the basic functions.

One interesting project was at the Thorvaldsens Museum in Denmark, visited by us in Copenhagen on 21 October 2004

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Mobile Phone Guided Tour SKULPTUREN KALDER!

Thorvaldsen Museum www.thorvaldsenmuseum.dk

Babak Djarahi, Sales Manager Cellpoint AB Denmark www.cellpoint.com

Marie Ørstedholm, information manager Thorvaldsens Museum.

The Golden Days in Copenhagen http://www.goldendays.dk is a major cultural heritage festival launched by the Copenhagen museums.

The aim is to promote the awareness of Copenhagen as a classical city of culture. The festival is a biennale facilitating the marketing of the permanent historical collections and traditional events the capital has to offer.

Golden Days in Copenhagen is sponsored by the Municipality of Copenhagen and the Danish Ministry of Culture.

Golden Days in Copenhagen took place in 2004 for the sixth time between 3 and 26 September 2004 under the title “The Age of Dreams - Copenhagen of the 1890s”.

The Thorvaldens museum is entirely dedicated to Bertel Thorvaldsen, one of the great Danish sculptors. Born in Copenhagen on 19 November 1770, he spent 40 years of his working life in Rome. He died in Copenhagen on 24 March 1844.

Within the scope of Golden Days in Copenhagen, the Thorvaldsens Museum organized Skulpturen Kalder!

The objective of this project was to make the inhabitants of Copenhagen better aware of the sculptures made in the last half of the 19th century, after Thorvaldsen’s death, that exist in their city.

The project was an idea of Pernille Damsted Fonnesberg, an art student working for the museum, and Ernst Jonas Bencard. Cellpoint, a Swedish company with an office in Copenhagen, made the application possible.

Visitors of the exhibition received a map of Copenhagen, showing the location of 15 artworks in different locations in the city of Copenhagen.

They could then dial a number with their personal mobile phones and type the number of the sculpture in front. They could then listen to the voice recording of a well known person – an artist, art critic, writer etc who would comment the work and give his or hers personal point of view.
In all, Cellpoint registered 1245 calls and a total of about 99592 seconds. This means that every call lasted about 1 min and 20 second.

Taking into account the date of the event – the middle of September – the language (Danish only) and the fact that very little promotion was made for the event, the organizers of this project are very satisfied with these results. At the moment, Cellpoint is discussing further projects with the Golden Days organization about a similar system for the Hans Christian Andersen anniversary festivities in 2005.

2.4.5.7 Portable geek gym

Philip Torrone from Seattle built himself what he calls a portable geek gym.

The portable geek gym consists of a pair of sunglasses with a half-inch square LCD screen incorporated into the right lens, a Pocket PC with video output, a Spot Watch that can receive and display news from the Web, headphones and a GPS unit. Also attached are a heart rate monitor and a pedometer that can be attached to a running shoe, all fed to a health watch via radio frequency. His phone, which is used to check email via bluetooth and feeds to the glasses, is optional.

The system plays audio and video clips based on his location, or shows GPS maps. He also made a setup where certain types of music are played depending on the area he is in. A future version might even support weather data.

So what is the link with Cultural Heritage? The setup that has been developed here could – at least technically – relatively easily be modified as a museum, site or monument heritage presentation system: content is sent to the sunglasses and the earphones when the visitor has reached a particular location.

In this illustrated case the content is music or e-mails. But it could just as easily be narration and video or historical information about a historic town, landmarks or an open air archeological site, automatically shown to the wearer when reaching an exact spot.

The nice thing about this location aware multimedia system is that Torrone only used hardware that is available off-the-shelf and made to work together with a lot of custom programming. This surely is a perfect example of integrating activities.

http://www.wired.com/news/gizmos/0,1452,62071,00.html

2.4.5.8 Tracking visits

With a portable location based information system – a GPS enabled PDA for example - the route a visitors follows, his pace, the duration of the visit, stops etc can be recorded by the device. This visitor data can later be downloaded into a PC as a ‘logbook’.

The xml file generated from most portable GPS systems can be imported into a PC and the route overlaid on top of satellite maps.
The image of the visit of a town or open air archaeological site could for instance be used to optimize the tour, or be given to the visitor as a ‘digital souvenir’.

### 2.4.5.9 Bluetooth wireless headphones

Bluetooth headphones function as full stereo headphones for any Bluetooth enabled laptop, handheld PDA, or MP3 player, and can also work with a cell phone as a wireless headset. They connect to those devices either natively or via a Bluetooth dongle. When working with a PC or PDA, they can be used for VOIP or any sort of voice chat.

Their action range is between 5 and 10 m. Their audio quality is better than that of Bluetooth headsets for mobile telephones, and work on both (stereo) channels. They are based on a new standard called Advanced Audio Distribution Profile (A2DP).

As with other Bluetooth devices, four-digit passwords could theoretically be established to secure the connection between the devices and the headset, adding the possibility to pair different headsets with for instance one PDA.

These PAN or Personal Area Networks are absolutely ideal in CH, because they allow a selected group of people – a family, a guided tour group – to hear the same audio stream, and even to talk to each other when the headset are also equipped with microphones, creating scope for cooperative visits and games.

We truly believe PAN technologies need further investigation and possible development for the CH domain.

Up to date, only a couple of companies, such as Bluetake Technology’s I-Phono, manufacture them. [http://www.bluetake.com/](http://www.bluetake.com/)

Logitech is developing a set together with HP.

In the ideal future all portable audio players will have built-in Bluetooth transmitters so that any Bluetooth headphone can be used with any audio player, just like wired headphones.

Zeevo Inc., a manufacturer of single-chip Bluetooth communications solutions, announced its third-generation, high performance Bluetooth microcontroller solution. According to them, is the first in the world to permit the transmission of CD-quality sound over wireless Bluetooth links.

The company’s ARM7-based Bluetooth controller and accompanying software forms a complete, low-cost embedded design solution for quality audio over Bluetooth, as well as for other performance-sensitive Bluetooth applications.

This means that Bluetooth – the wireless standard for connecting personal use devices with their peripherals – can be applied to portable MP3 layers, MP3-capable cell phones or PDAs, and even consumer stereo systems, to provide wireless connections to stereo headphones, headsets, or speakers without any sacrifice in audio quality.
Due to technical limitations, previous implementations of Bluetooth – used primarily for wireless keyboards, mice, or mono cell phone headsets – had not been able to attain CD-quality level that consumers have come to expect with their wired audio appliances.


We do not know whether these stereo headphones use the same chip as described above, but Logitech www.logitech.com manufactures these Bluetooth stereo headphones to use with HP's iPAQ Pocket PCs. You can listen to MP3s, videos, and any audio file at up to 10m from the iPAQ. Each headphone charge provides up to 8 hours of listening.

2.4.5.10 Bluetooth-Enabled Outdoor Posters

British mobile marketing company Hypertag has enhanced its outdoor infrared advertising posters with Bluetooth technology. According to the company, the new version will allow posters to send data such as video, vouchers, business cards, ringtones and games to the mobile phone or PDA of a person walking by.

The idea of beaming information via Bluetooth to a BT enabled device such as a PDA of a mobile phone is now finding its first use in advertising, but this same technology could be used to great advantage in museums and archaeological sites. As the reach of Bluetooth is approximately relatively short at 10m, written explanation, narration or images could be sent wirelessly to the mobile phones of visitors standing near an object or monument.

2.4.5.11 Blogs

A weblog, or simply a blog, is a web application which contains periodic, reverse chronologically ordered posts on a common webpage. Such a Web site would typically be accessible to any Internet user.

Blogs run from individual diaries to arms of political campaigns, media programs and corporations, and from one occasional author to having large communities of writers. The totality of weblogs or blog-related webs is usually called the blogosphere.

The format of weblogs varies, from simple bullet lists of hyperlinks, to article summaries with user-provided comments and ratings.

Individual weblog entries are almost always date and time-stamped, with the newest post at the top of the page.

Because links are so important to weblogs, most blogs have a way of archiving older entries and generating a static address for individual entries; this static link is referred to as a permalink. The latest headlines, with hyperlinks and summaries, are offered in weblogs in the RSS XML-format, to be read with a RSS feedreader.

A weblog is often run through a content management system or CMS.


2.4.5.12 Database Browsing

Smart search lets art fans browse from BBC New, 28 January 2005

If you don't know art but know what you like, new search technology could prove a useful gateway to painting.

ArtGarden, developed by BT's research unit, is being tested by the Tate as a new way of browsing its online collection of paintings.

Rather than search by the name of an artist or painting, users are shown a selection of pictures. Clicking on their favourite image will change the gallery in front of them to a selection of similar works.

Browsing

"It is much more akin to wandering through the gallery"

Jemima Rellie, Tate Online

The technology uses a system dubbed smart serendipity, which is a combination of artificial intelligence and random selection.

It 'chooses' a selection of pictures, by scoring paintings based on a selection of keywords associated with them.

So, for instance a Whistler painting of a bridge may have the obvious keywords such as bridge and Whistler associated to it but will also widen the search net with terms such as aesthetic movement, 19th century and water.

A variety of paintings will then be shown to the user, based partly on the keywords and partly on luck.

"It is much more akin to wandering through the gallery," said Jemima Rellie, head of the Tate's digital programme.
For Richard Tateson, who worked on the ArtGarden project, the need for a new way to search grew out of personal frustration. "I went to an online clothes store to find something to buy my wife for Christmas but I didn't have a clue what I wanted," he said. The text-based search was restricted to looking either by type of garment or designer, neither of which he found helpful. He ended up doing his present shopping on the high street instead.

**Music and film searches**

He thinks the dominance of text-based searching is not necessarily appealing to the majority of online shoppers. Similarly, with art, browsing is often more important than finding a particular object. "You don't arrive at Tate Britain and tell people what you want to see. One of the skills of showing off the collection is to introduce people to things they wouldn't have asked for," he said. The Tate is committed to making its art more accessible and technology such as ArtGarden can help with that, said Ms Rellie. She hopes the technology can be incorporated on to the website in the near future. BT research is looking at extending the technology to other searching, such as for music and films.

### 2.4.5.13 Bluetooth Messages

**Tate Britain Christmas Tree** by Richard Wentworth (an artist commissioned by Tate Britain) includes a Bluetooth antenna and receiver to which passers-by can leave 'gifts' in the form of photos, movies, text messages, and anything else that can be transferred as a file. On Christmas Day, the presents will be 'unwrapped' at [www.untitledfolder.org/christmastree](http://www.untitledfolder.org/christmastree).

This might just be an art project, the idea to be able to leave messages about an artefact or indeed the whole museum is appealing. It is sort of an electronic visitors' golden book. [http://www.gizmodo.com/gadgets/wireless/bluetooth/tate-britains-bluetooth-xmas-tree-026931.php](http://www.gizmodo.com/gadgets/wireless/bluetooth/tate-britains-bluetooth-xmas-tree-026931.php)
Eternal Egypt is a partnership between IBM and Cultnat to use innovative IBM technologies and services to create an interactive, multimedia experience of Egyptian cultural artefacts, places and history for a global audience.

How it works
Eternal Egypt is a relational database, in which all the data, images and multimedia files are stored.
It’s a user friendly CMS system for the visitor and for those who have to input content in the system.
The CMS has some specific properties which are interesting for utilization in cultural heritage. Dates e.g. are automatically placed on a timeline. This timeline is interactive, so by clicking on it, you have access to the information.
Relations between objects, places or persons are also visualized in an interactive ‘web’.
3D multimedia makes it possible to access places which are not accessible during a real visit, and an interactive map makes it possible to discover the history of Egypt starting from a particular place.

Eternal Egypt works with different output channels.
One channel is the website, www.eternalegypt.org, but PDAs, which can be used during a visit at the Valley of the Kings, are also a channel. So instead of making a different system for each output, the same information can be used in different ways.

Eternal Egypt contains a lot of automated processes. Pictures e.g. are automatically rescaled (for the different output channels) and thanks to an embedded Text-to-Speech engine, written text is converted into audio files.

On www.eternalegypt.org, you can store your visit and your favourite collection, which is a personalized way of visiting the website.
3 Horizontal Integration Unit

The methodology proposed by EPOCH is to have information on new technologies – press releases, technology reports and white papers – ‘pushed’ to us. In other words, EPOCH partners, companies, research organizations and universities are expected to keep us informed on the work and research they are doing. This way, we should not need to look for the information ourselves.

Unfortunately, this has not often been the case.

We have to admit that we expected a more effective and spontaneous information push from our EPOCH partners when the EPOCH website was activated after the VAST conference. Since that did not happen, we started a direct mailing campaign, with questionnaires sent to all the members of the EPOCH network, inviting them to inform us about the projects they were working on. Response to that has not been an enormous success, but proved useful none the less. Since with many projects it is not clear-cut whether the technology used has to be considered new or already existing, the choice was made to incorporate all the results to our mailing in the same database that was described extensively in WP 2.2. This database, and the end result of the projects – many of them EU funded – will need careful follow-up.

The same can be said about the private industry, be it from the ones we contacted or by companies that could have known about the EPOCH project. Unless we directly asked them for information, almost none kept us informed spontaneously or sent us leads about technologies that would find relevance in CH. Indeed, almost all the data that was gathered over the last year was found by ourselves on the internet, in specialised literature or at tradeshows.

Reason for this lack of cooperation is twofold: The Cultural Heritage domain, although extensive with thousands of museums, sites and monuments, is often not recognized by the industry as a potential market for their goods. Few products, let alone whole technologies, are developed specifically for use in CH. For the technologies that have been developed for other industries, but could be adapted to CH, this domain is so unknown to the manufacturers, the sales process so different from the private sector, that we are mostly overlooked. Furthermore, as museums are often not well funded, this sector is maybe not considered to be the most ‘productive’ market. Outside the network, the EPOCH project is as yet not very well known to the companies or organisations that should provide us with info. Indeed, with almost all the contacts we had with the industry, our first task was to explain what EPOCH was about, and what the potential for the companies and the CH sector might be.
4 Future outlines

It has been our task over the past months, and will continue to be in the future, to inform the private sector, research institutes and universities about our existence and 'raison d’être'.

We do this by promoting EPOCH in general and a new EPOCH website in particular. In the future, the Horizontal Integration website or Blog could be a good promotional instrument, kept dynamic by input from editors but also from participating contacts or partners.

So far we used direct mailing, but future initiatives might include a number of publications in specialized magazines and attending colloquia and tradeshows, where we will also present the EPOCH showcases.

By doing this, we hope to stimulate the inflow of information on technological developments, and arrive at a real technology-push collaboration with the industry and technology developers.

As suggested in the Stakeholder Needs report (WP 2.1), the research for all work packages should give priority to a bottom up approach, starting with data collection and processing and covering all successive steps of the “pipeline”, from data collection to dissemination. As said earlier, future research will cover all these steps.

5 Conclusions

Many of the technological developments we have seen have a clear potential for the domain of Cultural Heritage.

There are broadly 2 categories of technologies: those that improve on a known product or technology, and those that are fundamentally new and offer new perspectives yet unknown (to the world of Cultural Heritage).

An example of an improved technology is large format TFT monitors (they seem to grow in size every day). Images on these large screens can be viewed by a bigger audience, offering a better image, reduced weight and lower power consumption. But their technology is not fundamentally different from the one used on 17” PC monitors; they are only the result of advances in production process.

The same can be said about many other applications or technologies we have described in our blog. Most are the result of better production facilities, bigger production figures resulting in lower prices, that make many technologies that were once reserved for very specialised users suddenly accessible to everyone.

A good example is digital cameras: although these products are not new – they have been around for more than 10 years – they were mostly used by professional photographers with large budgets. Today, it is almost impossible to buy a digital phone that does not have an integrated camera.

This trickling down of technologies is of course of the biggest importance to our market.
An exercised mind will be able to develop new concepts, products and applications based on now commonly accepted and generalised products, such as mobile phones or digital camera’s.

These different approaches can result in better interactivity with the visitor of a museum or archaeological site. Good examples have been found and are described in the following pages, some of them in Cultural Heritage or very similar domains.

Another category of technologies are those that are completely new.

Some of them offer completely unknown perspectives in Cultural Heritage.

We therefore strongly believe that these are the technologies that need to be further investigated and developed.

The first is **Radio Frequency Identification** or RFID.

This technology – which is described further in detail in the appendix – is developed primarily for the retail and cattle industry. In a way, RFID’s can be compared to barcodes, where a unique code is read into a database. These tags can however be read from a distance – ranging from a few cm to many meters – when they pass in front of a reader.

RFID technology has many potential applications in CH, from the tagging of artefacts – the metadata of which can be read without touching the object – to embedding tags into admission tickets of museums, so these can trigger multimedia applications from a distance.

Tagging artefacts, objects and paintings will open new ways of asset tracking and security systems, but also pave the way to innovative content presentation systems.

If each object in a museum is tagged, a multimedia application on a portable device such as a PDA, equipped with an RFID reader, could (automatically) show information when that object is reached. Depending on the intended target group, this info could be scientific, managerial, or informative.

The PDA could receive the data – text, images, video and sound – kept on a central database over a wireless network. If the visitor chose the topic that interests him the most, say a certain historical period, he could be directed towards the most relevant exhibits by his PDA.

RFIDs imbedded into the admission ticket are able to start and configure multimedia systems from a distance. As a kiosk would for example be able to recognize the visitor, even which one arrived first, it could adapt its content according to age group, language or interest.

The main culprit, and greatest danger in deploying RFID in the CH domain, is the lack of standards. There are different technologies, frequencies etc, and to our knowledge no rules for defining the unique tag ID.

Deciding on standards for RFID use in CH is a project in itself, choosing the technology another one.

Another technology group that deserves further development in CH are **Personal Area Networks**, or PAN.

Bluetooth allows communication between different devices over a short distance. This communication protocol makes small workgroups possible, without interference from other visitors. A family can share the same audio comment on a portable device over Bluetooth headphones, and interact without being heard by other visitors.

There are a lot of devices on the market, such as PDAs or mobile phones that use Bluetooth and a number that are starting to show, such as Bluetooth enabled stereo headset. What has to be developed now are the right applications and content to use these in Cultural Heritage.
New wireless technologies and **user location systems** – GPS, Wireless LAN – make it possible to send content to a user when and where he needs it. These location aware devices could give rise to a whole new spectrum of services, from guidance systems to games. Interesting applications and good content could be designed here, probably at little cost as all the hardware is readily available off the shelf.

Reversely, as location aware devices can remember where a visitor has been, this info can be used by museum or sites to improve their tours and services, or by the visitor as an e-trail.

Whatever technology already on the market or developed in the future: when deciding to use one or develop applications for it, such fundamental elements as cost effectiveness, maintainability and sustainability must not be forgotten. This is particularly true of the CH domain.

As our research has shown in the Vertical Integration work package 2.2, most problems arising from the use of even seemingly simple technologies such as interactive kiosks stem from the – inherent to the Cultural Heritage domain – lack of technical knowledge of those who have to maintain them. When introducing new technologies to the CH market, education and training will therefore be one of the major factors defining success or failure.

Specialised maintenance structures or organisations might even have to be set up, maybe sector or technology wide, instead of dependent of one museum or site.

To conclude, one caveat: any technological development has to fit the needs of archaeologists, museums, sites and visitors. If not, the integration of new technologies will further alienate those users from the opportunities that are created by technology in the Cultural Heritage domain.
6 Bibliography

6.1 Conference proceedings

Siggraph  http://www.siggraph.org
VAST  http://www.enamecenter.org/pages/events_past_VAST.html
CAA  http://www.caaconference.org/
ICHIM  http://www.ichim.org/
CASA  http://www.miralab.unige.ch/subpages/casa2004/index.cfm

6.2 Technology watch reports

Digicult  http://www.digicult.info/pages/techwatch.php

Technology Watch Reports

The DigiCULT Technology Watch Report is a major annual volume, covering six technologies expected to have a substantial impact on the future of cultural heritage projects, professionals working in the sector, and approaches to cultural materials. Their primary aim is to give a solid and impartial grounding in new and developing technologies to those without the time or the IT confidence to gain an independent familiarity, together with a view of the changing technological and methodological landscapes.

JISC  Joint Information Systems Committee  http://www.jisc.ac.uk/

Technology and Standards Watch

Technology and Standards Watch helps keep track of developments in information and communication technologies that might have high impact on the core business of Further and Higher education in five to ten years' time. It commissions reports on specific technologies and provides many links from this site to technology resources elsewhere on the Web.

6.3 Technology watch websites

BBC technology  http://news.bbc.co.uk/1/hi/technology/default.stm
Endgadget  http://www.engadget.com/
NearNear Future  http://www.we-make-money-not-art.com/
Futurefeeder  http://futurefeeder.com/

And many others